What can a sonic assemblage do? A biopsychosocial approach to post-acousmatic composition

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This dissertation is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated. No part of this dissertation has been submitted to any other university. The dissertation contains no more than 63,000 words

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And finally, this thesis is dedicated to my mother, brother and to the memory of my late father Ayyaz Ahmad Bhunnoo (1943 – 2011) a proud and independent mind whose post-colonial journey always questioned the apparent status quo of the world.

Declaration

I grant power of discretion to the university librarian to allow this thesis to be copied in whole or in part without further reference to the author. This permission covers only single copies made for study purposes, subject to normal conditions of acknowledgement.

Related publications and conference papers

Some material in this thesis has developed from earlier formulations in the following publications:

- Ayyaz, S. (2015) *Listening Through a Beam of Intense Darkness*. London: fig-2, Institute of Contemporary Arts.
- Bhunnoo, S.A. (2013) 'In the midst of it all, something is stirring: The biopsychosocial condition of listening'. In Carlyle, A and Lane, C (eds) *On Listening*. Axminster: CRiSAP Uniform Books, 183–7.
- Bhunnoo, S.A. (2013) 'Structures of listening and composing: A biopsychosocial approach'. Paper presented at a symposium on acoustic ecology, University of Kent, 8 November.
- Bhunnoo, S.A. (2012) 'What can a sonic body do? The biopsychosocial condition of listening in composition-performance practice. Presented at the 'Music and the body' conference, University of Hong Kong. Online. http://www.music.hku.hk/events/conferences/music-body/
- Bhunnoo, S.A. (2011) 'Reconfiguring the Islamic sonic-social in the bird ghost at the zaouia by Seth Ayyaz'. *Organised Sound*, 16 (3), 220–9.
- Ayyaz, S. (2010) 'Reconfiguring the Islamic sonic-social: the bird ghost at the zaouia by Seth Ayyaz'. Paper presented at Ideologies and Ethics in the Uses and Abuses of Sound, international conference of the World Forum for Acoustic Ecology, Koli, Finland, 16–19 June 2010.
- Ayyaz, S. (2010) 'The bird ghost at the zaouia'. Paper presented at the Middle East and Central Asian Music Forum, University of London, School of Advanced Study, Institute of Musical Research. 7 May.

- Bhunnoo, S.A. (2008) Review: 'The music effect: Music physiology and clinical applications' by Daniel J. Schneck and Dorita S. Berger, pub. Jessica Kingsley, 2006. *Journal of Mental Health* 17 (3), 341–4.

- Ayyaz, S. (2007) 'The use of computational evolutionary algorithms in composing the bird ghost at the zaouia'. Paper presented at the Music and Evolutionary Thought conference. Durham University, June.

Portfolio of compositions

The portfolio of original sound pieces submitted as part of this doctoral research is outlined below, with the titles of the works, the files submitted and a brief description. They are discussed in the thesis and additional information is included in the Appendices [indicated in square brackets].

Fixed assemblages

On the Admissibility of Sound as Music and Art is an umbrella title for three related fixed-form electroacoustic pieces comprising the following:

1: the bird ghost at the zaouia (2011) [A1.02]

FORMAT: Two versions:

1. **fixed electroacoustic concert version (7.1 channel; 96KHz audio; duration: 30:09).** 8 mono audio files submitted: 1 BGZ_Lf.aif, 2 BGZ_Rf.aif, 3 BGZ_Lm.aif, 4 BGZ_Rm.aif, 5 BGZ_Ls.aif, 6 BGZ_Rs.aif, 7 BGZ_C.aif, 8 BGZ_LFE.aif (arrangement can be loaded into: the bird ghost at the zaouia (vienna concert mix).logicx)
2. **fixed electroacoustic concert version (stereo; 96KHz audio; duration: 30:09).** 1 stereo interleaved audio file submitted: the bird ghost at the zaouia (stereo vienna concert mix).aif

DIFFUSION: see 'BGZ vienna diffusion 7_1 schematic.pdf'

ADDITIONAL MATERIALS: see APPENDIX A1.02

spectral analysis: the bird ghost at the zaouia (stereo vienna concert mix).png

2: Makharej (2010) [A1.03]

Electronics and voice, featuring Amira Ghazalla (voice). Two versions are referred to in the thesis. Makharej live (MazaJ, 2010) is a video documentation of a live performance at Volatile Frequencies, City University, London, part of the MazaJ Festival, on 18 November 2010.

FORMAT: Two versions:

1. AUDIO: **fixed electroacoustic concert version (stereo; 96KHz audio; duration: 23:56).** 1 stereo interleaved audio file submitted: makharej (stereo) | 96.aif.
2. VIDEO: live performance at Volatile Frequencies concert at City University, London, part of the MazaJ Festival,18 November 2010. 1 movie file submitted: makharej live (MazaJ 2010).m4v (video, resolution 640X360, AR: 16:9, FR: PAL; stereo audio of 8 channel performance; duration: 24:48).

DIFFUSION: standard stereo

ADDITIONAL MATERIALS: see APPENDIX A1.03

spectral analysis: makharej (stereo fixed) | 96.png

3: The Remainder (2013) [A1.04]

Commissioned for Maerz Music, Berlin, 2013.

FORMAT: Two versions:

1. **fixed electroacoustic concert version (8 channel; 96KHz audio; duration: 13:20).** 4 stereo audio files submitted: The Remainder M4 FRONT 1+2 | Lf + Rf.aif; The Remainder M4 REAR 7+8 | Lr + Rr.aif; The Remainder M4 SIDE 5+6 | Ls + Rs.aif; The Remainder M4 WIDE 3+4 | Lm + Rm.aif
2. **fixed electroacoustic concert version (stereo; 96KHz audio; duration: 13:20).** 1 stereo interleaved audio file submitted: THE REMAINDER (stereo, -3dB, 96/24).aif

DIFFUSION: see 'The Remainder diffusion 8ch schematic.pdf'.

ADDITIONAL MATERIALS: see APPENDIX A1.04

spectral analysis: THE REMAINDER (stereo, -3dB, 96:24).png

Live assemblages

The following are documentations from live performance pieces.

4: Batroun Concrète (2012) [A1.05]

Hybrid electroacoustic, with live performance score.

This was initially commissioned for the opening of the Batroun art space in Lebanon which resulted in Batroun Concrète 0.0 (2011, not submitted), a fixed electroacoustic work which took the site as its subject. The work evolved, with the addition of a score for four site-specific performances to be interleaved into five electroacoustic sections. It was to be performed as part of the arts event Quantum Fluctuations in a Synechdochic Universe, based around Beirut, 4–9 December 2012. Unfortunately, the beginning of the Syrian civil war resulted in the concert being abandoned. The piece has not been performed in its complete form.

FORMAT:

1. AUDIO: **fixed electroacoustic concert version (2 channel; 48KHz audio; total duration: 19:12)** contains the following fixed parts: part 2.1 (duration: 07:24); part 2.3 (duration: 02:12); part 2.5 (duration: 02:43); part 2.7 (duration: 02:54); part 2.9 (duration: 03:33). 1 stereo interleaved audio file submitted: Batroun Concrète | 2.1 2.3 2.5 2.7 2.9 | 48.wav

2. SCORE: Batroun Concrète 2.0 Score.pdf

DIFFUSION: standard stereo

ADDITIONAL MATERIALS: see APPENDIX A1.05

5: Reed | Skin | Elektrik (2010) [A1.06]

Solo live electroinstrumental four channel improvisation using the earliest version of the *hQi.live* system at the MazaJ Festival in London in 2010.

FORMAT: Two documentations of performance:

1. AUDIO: **live electroinstrumental performance (4 channel; 44.1 KHz audio; duration: 30:32).** 4 mono audio files submitted: Reed Skin Elektrik.Lf.aif; Reed Skin Elektrik.Rf.aif; Reed Skin Elektrik.Lr.aif; Reed Skin Elektrik.Rr.aif;

2. VIDEO: **live performance at Cafe Oto, MazaJ Festival, London 2010.** 1 movie file submitted: Reed Skin Elektrik.m4v (video, medium resolution 640X360, AR: 16:9, FR: PAL; stereo audio, duration: 30:05).

DIFFUSION: see 'RSE diffusion 4ch schematic.pdf'.

ADDITIONAL MATERIALS: see APPENDIX A1.06

spectral analysis: Reed Skin Elektrik.png

6: Dark Geometries (2016) [A1.07]

FORMAT: Documentation of performance, and accompanying film by Gill Ord

1. AUDIO: **live electroinstrumental performance (4 channel; 96 KHz audio; duration: 25:34)**. 2 stereo interleaved audio file submitted: Dark Geometries Live 1+ 2 | Lf + Rf.wav; Dark Geometries Live 3+ 4 | Lr + Rr.wav; (arrangement can be loaded into: Dark Geometries.logicx)
2. VIDEO: Blochaus by Gill Ord (no audio, to be played on loop against above). 1 movie file submitted: Blockhaus | Gill Ord.mpeg (video, high resolution 1920 x 1080, AR: 16:9, FR: PAL; no audio, duration: 3:55).

DIFFUSION: standard quad

ADDITIONAL MATERIALS: see APPENDIX A1.07

Abstract

What can a sonic assemblage do? A biopsychosocial approach to post-acousmatic composition

Thinking and sounding are two terms which complicate one another, hence this thesis follows two trajectories each of which make an original contribution to knowledge. *Part 1* (thinking sound) proposes to reground composition away from historically authoritative humanist models, instead suggesting a biopsychosocial approach for a post-acousmatic music. I elaborate a set of models and key concepts, chiefly an eliminativist account of the listener-sound relation; neurocognitively discrete musical domains and dimensions of the K-matrix; model-based reasoning through a Reception-Interpretation-Action helix; and, mentalizing listening stances based upon dual-process cognition models. This is combined with an art-activist stance where composition is concerned with the effects that a sonic art-object exerts in its vicinity. I propose composition as experimentally concerned with generating new epistemic things through a process of assemblage and heterogeneous engineering. *Part 2* (sounding thinking) discusses fixed and live compositions which initiated and respond to my proposed approach. In my practice, I focus on the disruption of specific aesthetic regimens to bring listening into attentional focus, engaging the specificity of the mnemonic traces that sound leaves. The pieces are largely concerned with sonic cultures related to Islam and the MENASA region.

Part 1: Thinking sound

Now everything that is rule or repeated constraint is part of the mental machine. A little 'imaginary machine,' Philippot [the painter Michel Philippot] would have said a choice, a set of decisions. A musical work can be analyzed as a multitude of mental machines. A melodic theme in a symphony is a mold, a mental machine, in the same way as its structure is. These mental machines are something very restrictive and deterministic, and sometimes very vague and indecisive. In the last few years we have seen that this idea of mechanism is really a very general one. It flows through every area of human knowledge and action, from strict logic to artistic manifestations.

Xenakis 1992: 132

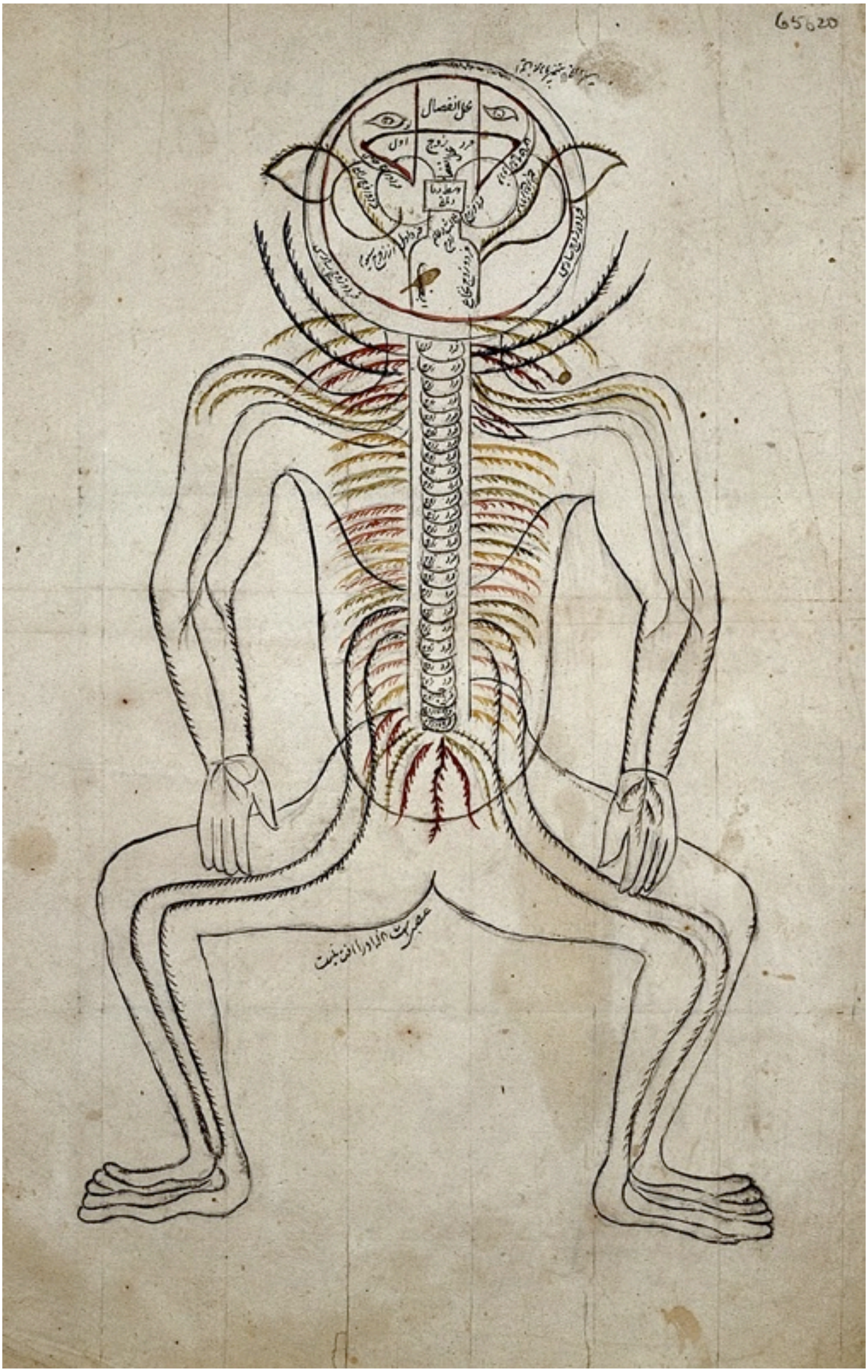

Figure 1: Image by 14th-century Persian anatomist Mansur ibn Muhammad Ilyas. Treatise on the anatomy of the human nervous system

Chapter 1

Exiting the acousmatic

1.1 Sound and trace

We are immersed in an ocean of global sound which never stops. Sound has terrain; spatial, temporal and spectral localities, where listening alights and drifts again, off to discover imaginary islands and unknown continents (Toop, 2001).

Sound, by its marks, places us in the world, which we mark by cacophonous sounding. Schizophonia hearkens for a time before electroacoustic reproduction, a 'pointer towards a less alienated relationship of man to nature and a pejorative label for the presence of amplified sound in culture' (Gardner, 2011: 52). In Plato's *Republic*, we are told that the size of a city was anthropometrically set by the human voice's natural reach (Schafer, 1977). Passing ineluctably into li-fi noise, sound conveys industrialisation and human acceleration towards universal anacusis (Schafer, 1994). In this thinking, sound conveys nostalgia and utopian fantasies of how we might retune the world to our image.

Sound echoes higher realities. For those chained in the puppet dance of Plato's famous cave, it is ever only a reflection back from the shadows (Marsden 2014; Alexandrakis, et al. 2015). Like the 'dark enigma' of the noises from the Moodus Cave which open Brian Kane's *Sound Unseen*, sounds are 'bridges between the visible and equally real invisible worlds' (Kane 2014: 2). They may be mythical phantasms, distilled into being by the mediumship of the listener (Toop 2011). Or perhaps sounds originate from beyond a veil, an image enhanced by the absence of vision (Schaeffer 1966; Chion 1994).

As topological plane, sound folds and unfolds; noise forms into sound and sound unforms to noise (Deleuze, 2003). The image of sound may be abstract or obtuse, as subterranean rhizomatic threads 'some tangled, some rooted and some uprooted or flattened' (Aracagök, 2009: 1), or even as eroticised soaring dogs 'doing nothing but resting in the air' (ibid: 4).

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Sound, whether musically organised or not, is a strange intangibility to listening, only partially graspable through the images that its trace in language conveys. It appears that we are ensnared in a correlation[1], an adjacency between listener and what is listened to, predicated on a subject-object divide that epitomises the Kantian phenomenon-noumenon split. Most of the numerous theories of music and art are predicated upon this distinction:

> […] with the status of the object's art-ness located not in the object, but instead in the nature of the relationship between the object and subject (Whitehead, 2013: 11).

Cage's silence and cultivated indifference, Schaeffer's acousmata, Schafer's preservation of sound's traces threatened by extinction, Westerkamp's sonic meditation on *Kits Beach* are all heard because of this correlation (Schaeffer, 1980; Westerkamp, 1989; Cage, 2011). Listening might be said to compose sound because of a 'peculiar form of attention or alertness', a perspectival attitude of mind taken by a subject in relation to an object (Smith, 2014).

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Early in my research, the Electro-Acoustic Resource Site returned 851 articles under 'listening mode', and more than 50 types of listening: acousmatic, causal, semantic, organisational, referential, spatial, technological, schizophonic, structural, deep and so on (EARS, 2012). Electroacoustic music (EAM) appears predicated on a proliferating phenomenological taxonomy of listening, reminiscent of the predicament in 18th century biology which, lacking the deep structure of genetics, offered a bewildering speciation based on appearances, on morphology.

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[1] This philosophical term is discussed in Chapter 2.

While the discursive can certainly sharpen thought and perception, I nevertheless see a problem. Sound has become highly ventriloquized, colonised and territorialized[2] by the Sunna and hadith of authoritative discourses, vying sonic Sharia that overtly or clandestinely discipline compositional practices.

While we can write about music or sound, we cannot adequately emulate the experience of the sound as we have it. Sound, as a materiality, passes transparently right through us, capturing a topology for which we have only partial representational access. And yet, when we speak about sound we usually insist on forcing it into signification. We cannot make sound-in-itself actually speak, or rather if we say we do, we no longer have the sound, but its representation. While there is a certain geometry between sound and its trace in listening, this relation is ultimately irreversible; we can only speak about how it appears to us, because it cannot be reduced to its own identity (Wilkins, 2016).

Although we cannot communicate the entirety of the perception of sound, because this cannot be fully articulated in words, it does not mean we cannot speak about it. Rather, we must be cautious and not believe that sound is speaking for itself, and that we are accessing an absolute of sound on its own terms. This vibratory material-acoustic energy is ungraspable to us in experience. Rather, we produce our listening by capturing the phantasm in the aether from the oceanic sound that immerses us. All that we have, in

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[2] I am referring to de/reterritorialization in the sense developed by Gilles Deleuze and Félix Guattari (1983), the dissipated and fluid nature of human subjectivity in the context of contemporary capitalism. It relates to Michel Foucault's insights regarding discourse analysis, where various disciplining and discursive formations underlay the structure of human practices (Deleuze, 1986). Generally, it describes any process that de-contextualises a set of relations, and which renders it virtual and potentially applicable to other contexts and more distant actualisations. In *Anti-Oedipus*, the authors discuss economic and psychic deterritorialization, critically drawing parallels between Marxist and psychoanalytic traditions. It is used anthropologically in relation to processes of cultural globalisation, emphasising cultural–spatiotemporal territories as much as institutional or political economic processes. Through its application to global mediatisation, the concept broadens towards territories staked out by discourse and language that impacts, constitutes and reconfigures imagination (Appadurai, 1990, after Hernàndez i Martí, 2006; Tomlinson, 1999).

auditive introspection, is the trace that it leaves when material-themselves pass into audibility or are received through some other sensible mode.

We can only communicate sound's saliences, the markers that we detect in it that differentiate one sound from another, and which formulates this distinction. Through these saliences, trace forms[3], a material inscription, whether mnemonically into internal neural networks, or externally into hard drives or parchment scrolls whose potential may 'only be revealed as force rendered through sensation' when becoming audible (Bogue, 2003: 165). Trace operates as a cognitive handle, a neural 'token' (Griffiths et al., 1999: 366), accessing a perspectival 'address' (Mazzola, 2002: 63), marking the location of a 'topological neighbourhood' (Negarestani, 2013: 200) for sound-in-itself, which has been filtered by our neurobiology – ancestrally coevolved with prehistoric soundscapes – and enculturated individual biases, desires and affiliations (Fitch, 2006; Meschiari, 2009). Trace is a contraction of the acoustic, at times a biosignal centripetally received from sensory periphery to cortex, at times a material code awaiting an ear–brain.

Trace is also an expansion. It joins with other traces, ramifying through associative networks forming and being elaborated by linguistic devices (Patel, 2008). But this is not sound. Through communicability trace becomes woven into language, its saliences transform, its mark diversifies as its territory[4] evolves and proliferates (Deliege, 1996; Juslin et al., 2003). Through language and historic practices, trace is inevitably organised according to some mode of territorialization or another, of some discursive and disciplining regimen

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[3] This trace is formed primarily through the auditory object (that is not identical with the Schaefferian sound object) which is discussed in Chapter 3.

[4] Terrain, territory and territorialization are three terms that confer differing shades of power (Eden, 2010). Terrain has a heritage in geology, biology, military strategy and sociology; the control of spatial geographic areas that allows the establishment and maintenance of order. 'As a "field", a site of work or battle, it is a political-strategic question' (ibid: 804). Territory is primarily a juridical–political concept (sovereignty, jurisdiction and authority); a form of political technology 'dependent on a number of techniques' (ibid: 809) such as cartography and geometry that conceptually map a space. I take it as the outcome of territorialization as an active and historically contingent process.

and coding. Every discourse about sound therefore conveys a world view, it is politically inflected. The question is the degree to which we acknowledge it; the degree to which we erroneously attribute it to the sound-itself.

As Konstantin Raudive's *Electronic Voice Phenomen*a shows us, trace is a projective Rorschach (Banks, 1999). The audible trace is actively fabricated in the convergence between centripetally trajecting material event, its capture by perceptual-inferential neural machinations and its expansion through centrifugal central neural processes[5] (Evens, 2005; de Cheveigné, 2006). Trace, as sound's image, is then also configured outwards towards the ear (Zatorre, 2007). Trace is not by necessity always a correlation to an external event. To an extent, it is an apophenic function emanating towards the auditory cortices from within higher cortical systems, modulated and constructed by desire and expectation (Fyfe et al., 2008). Rather than being relegated to psychopathology, or ecstatic mystical states, the apophenic infuses sound as a mode of hearing that functions on the basis of traces.

Sounding these traces, that is composition, is an oneiric activity ensnared between acoustic–event and its refiguration through, 'a waking trance to dream the spaces in which images […] give meaning to each other' (Reiner, 2012: 48). It is activity within a self-representing biosystem which pulses out into causal networks that assemble heterogonous materials; tracing material operations with apophenic force, dreaming itself and a world, capturing, generating and recirculating acoustic evental flows, encountering the sonic as an agentive object, a not-yet-known, a chimera.

1.2 Making a beginning

Electroacoustic theories and practices have drawn broadly from knowledge produced by other fields. This thesis proposes ways in which that intellectual permeability can leverage

[5] A variety of processes, and the term process, appears frequently in this writing. Process is, 'A coordinated group of changes in the complexion of reality, an organised family of occurrences that are systematically linked to one another either causally or functionally' (Rescher, 1996: 38, after El-Hani *et al*., 2009).

what it can be and do, specifically by exiting the acousmatic in its extant formulation. Might a post-acousmatic practice function otherwise, and, if so, for what ends?

This writing is a transdisciplinary alloy of artistic and scientific insights. It proposes a framework that engages interactions of the material biological, psychological and social systems that form the conditions of electroacoustic musicking[6]. I ask how thought might be restructured with respect to sound; and how sound's specificities promote an exploratory, systemic and experimental practice that might shift the parameters of how post-acousmatic art functions. In this section I contextualise this research and the accompanying portfolio of compositions.

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I began in the midst of a perplexing oscillation between the pragmatics of compositional techne, and the theoretical work of accounting for those practices – a problem of 'playing and saying' that besets musicking and its thinking (Cook, 1999).

In a particular EAM culture at City University, I inherited from the 'acousmatic situation' with its emphasis on the phenomenological reception and privileging of this listening without seeing (Schaeffer, 1980: 9; Chion, 1994). As a genre, acousmatic practice is usually traced to *musique concrète* and Pierre Schaeffer[7] who was emancipatory in allowing all recorded sound into the ambit of composition, an approach that continues to have traction (Adkins, 2007; Ziherl et al., 2011). I critically engaged the acousmatic as a sociotechnical condition of EAM, as a 'thesis' relating to aesthetics (Hamilton, 2007) and as a 'dilemma' relating concrete sound to the 'intrinsic musical space' that composition is purported to engage (Ojala, 2009: 356). It was also a problem, with its claim of accessing a realm of

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[6] I prefer the verb 'musicking' to capture a process of forming rather than fixing as a noun (Small, 1998: 9).

[7] Whilst Schaeffer systematised and theorised the approach of *musique concrète*, his position as originator of *concrète* techniques is contestable. The studio manipulation of real–world recordings predates Schaeffer, for example by Halim El Dabh in his piece *Ta'abir Al-Zaar* (Wire Recorder Piece) which was made in Cairo in 1944.

sound-for-itself, and determining composition as restricted within the perceptual horizon, ideally under the optimal conditions of specially treated and rather elite listening circumstances.

The discipline of detailed introspection into auditive experience was highly valuable. However, the undoubted technical skill of articulating pristine aesthetic illusions in digital panoramas, the game of perception targeting its own self-conception, seemed to lack an outside. Drawing attention to alternative modes of subjectivity, Deleuze and Guattari famously proclaimed that:

> […] [the] schizophrenic out for a walk is a better model than a neurotic lying on the analyst's couch (Deleuze and Guattari, 1983: xix).

It seemed that the acousmatic promoted a carefully constrained sounding, one that lacked a commitment to the untamed force of sound as an agent in its own right, out for a walk in the 'Great Outdoors' (Saldanha, 2009). While this may be thought an over generalisation, my misgivings prompted me to consider what the basic assumptions of the EAM game might be, which opened a trajectory towards rethinking it.

I found the Husserlian grounding of Schaeffer's phenomenological approach problematic, having found it discredited in my other line of professional activity (which I shall come to shortly). I looked further afield at soundscape composition and the related acoustic ecology, and various computer music traditions, often finding dissatisfaction on similar grounds: the norms of human phenomenality taken to constrain what practice might be.

❊

Initially I thought my frustrations stemmed from the heterogeneity of my practices and interests. On the one hand, multichannel fixed composition, free-improvisation, custom built performance systems, electro-instrumental ensemble composition and performance, Noise, sound installation, generative coding, Islamic classical musics (as nay[8] and daf player), and bass culture. On the other hand, digital signal processing, object-oriented programming, sound engineering, psychoacoustics, cognitive neurosciences, psychology, psychoanalysis, philosophies of science, mind, art and music, sociologies such as actor–network theory, anthropology of art, ethnomusicology, Islamic studies, sound studies, and critical theory.

Thinking sound in terms of such eclecticism seriously risks what the art historian Barbara Maria Stafford terms 'weak collage', the stringing together of similar phenomena from disparate eras and spheres, but lacking any deep structure that binds them together (Stafford, 2008: 5). The need for deep structure to the conceptual architecture motivates my approach.

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A key factor stems from my work and training as a psychiatrist, where I spend a great deal of time in a peculiar mode of listening, with people in pathological states of mind. This convinces me of the precarity of consciousness and knowledge gained by sensory experience, and the illusory nature of the unified self. In short, I am suspicious of taking human phenomenality at face value, even in a domain such as music that seems so predicated on representational and sensory experience. I am mindful of the apparent uniquity of first-person subjectivity and its tension with third-person scientific accounts of experience. This was a key impetus behind my research on the subject-object relations that underpin listening, and my suspicion of notions of the acousmatic and its implication of a transcendentally ideal listening subject.

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A third factor influencing this research is that a great deal has been stirring outdoors, geopolitically speaking. Being of Muslim heritage, these events became a significant impetus

[8] The nay is a type of end-blown flute, and daf a frame drum which are found throughout the MENASA, and are closely associated with Sufi practices.

to some of the compositions, through extensive travels in the MENASA[9] region where I encountered the 'ethically-tuned sensorium' (Hirschkind, 1987) through its technological disseminations and engaged various discourses that discipline sound in the fricative play of power between 'occident' and 'orient' (Nooshin, 2009).

By utilising highly charged, and at times culturally specific and semantically loaded trace, I had to consider the practices by which these might be organised, and in particular to think through the 'structuring of the aesthetic as an act of political force' (Mackay et al., 2014: 3) which did 'something more than the provocation of moments of alienation or evanescent sentiments of liberation' (ibid: 6).

These biographic factors served as comparative disciplines of sounding, listening and thinking and brought me to return to an ongoing problematic: the valorised place of listening as idealised entity in acousmatic practice, and the wider issue of compositions' engagement with human phenomenality as its central metric. I found myself dissatisfied with 'the established canonical discourse' (Adkins et al., 2016: 106). However, I am also indebted to them.

1.3 The post-acousmatic situation

The term post-acousmatic is appropriate as I argue for a trajectory that remodels theory and practice outside of the 'manifest image' (Sellars, 1962, after Mackay *et al.*, 2014: 5), the traditional humanistic self-conception of the acousmatic listening-composing mind. In sympathy with Adkins, Scott and Tremblay, I want to retain a focus on, and augment electroacoustic practices while jettisoning the normative and prescriptive compositional discourse that has accrued around the acousmatic (idem).

In its favour, 'referring to a sound that one hears without seeing the causes behind it' (Schaeffer, 1966, after ibid: 107) highlights the synthetic acts of consciousness that

[9] Widely used in academic and cultural contexts the acronym MENASA refers to the Middle East, North African and South Asian geocultural areas.

composition may critically engage and redeploy. However, I reject the Schaefferian position of the ideal subject that is transcendent to its object. I value auditive experience, probing and exceeding listening, but do not think practice must by any necessity conform to representational processes, however, neither should it ignore them. Rather, these become moving targets for sound's trace, through a lexicon that is developed in Part 1. The term 'acousmatic' has come to be a cultural code for:

> […] a paradigmatic practice that has extended beyond mere listening to include social organisation, ways of thinking and the meta-levels of organisation that go into the construction, organisation and maintenance of a genre and its attendant institutions and communities of practice (Adkins et al., 2016: 107).

I confess little interest in much of this paradigmatic practice, and view its solipsistic and 'over-formulaic approach to gesture, pacing and mood' (Prix Ars Electronica, 1997, after ibid: 108) not only deadening, but also complicit with certain aesthetic regimens of social control. Some of these complicities are discussed in Chapter 4. Their disruption is applied in the triptych *On the Admissibility of Sound as Art and Music,* particularly in *the bird ghost at the zaouia*, and *Makharej* which deal explicitly with aspects of sonic Orientalism[10] and Islamic sonic culture. I see this as a consequence of not engaging Arun Saldanha's 'Great Outdoors' in two senses. Firstly, acousmatic music's lack of critical engagement with 'the social and cultural' (Waters, 1997: 3, after ibid: 108), not only by bracketing it out in listening, but also by its general lack of engagement with wider cultural theoretical developments, especially critical thinking about the nature and purpose of artistic practices. I think this is behind Seth Kim-Cohen's call for a non-cochlear and more conceptual approach (Kim-Cohen, 2009).

The second outdoors is an intellectual and technological revolution that has taken place in the sciences. In the domain of visual cultures, Barbara Maria Stafford has impressively advocated just such an attempt and she notes:

[10] I develop the term after Edward Said (1978).

> [The] cognitive revolution continues to meet with the 'intense reluctance' of arts, cultural, and literary historians to consider seriously the biological underpinnings of artificial marks and built surfaces (Stafford, 2008: 1, quoting from Richardson and Steen, 2002: 1–8).

The full impact of this reworking of the horizons of thought has yet to be fully registered in the fields of composition and musical scholarship; hence Chapter 3 applies such an approach to exiting the acousmatic. This research generally resonates with the post-acousmatic non-genre, as Adkins and colleagues describe it:

> The post-acousmatic emerges from some significant sense of relationship to the acousmatic. We consider it useful here to think of multiple trajectories of musical practice arising from the acousmatic rather than linear generic development or postmodern collage. This inevitably involves recognition of the limitations and relative narrowness of acousmatic music in the face of varied and complex contemporary musical practice [...] a clutch of interrelated augmentations of acousmatic practice, some of which may express contradiction and critique of acousmatic practice, can be discussed. There is no real need to unify them beyond their genetic relation to the acousmatic, or to establish a common aesthetic artificially, a community or indeed a post-acousmatic genre. Therefore, the post-acousmatic defines a group of practices in relation to the acousmatic rather than a specific paradigmatic practice in itself, and the apposition of the 'Post-' prefix, by opposition to a completely new word, is an open and clear acknowledgment of the common parenthood and strong positive influence of (at least) the first three decades or so of the acousmatic genre within these burgeoning new musical proposals (ibid, 2016: 111).

In terms of practice, Adkins and colleagues give a nodal configuration differentiated through the construction and function of time, form, production and performance. I will not discuss the model specifically, but it is a useful way of locating the pieces submitted here. They distribute across sound-based and timbre-based procedures; employ both pristine hi-fi and noise based, low-tech production values; some are fixed, but exist in several durations for different presentational contexts; others are entirely live and improvised; and one exists both as a fixed work and a site-specific action-score that is in the interstice between sound-art and music:

> It seems that the time is ripe, after a century of technical acquisitions, that electroacoustic composition concerns itself about its application and stops to consider simple digital audio innovations as musically satisfying (Dhomont, 2008, after Adkins et al., 2016: 121).

In a practice-based thesis, it would be usual to proceed by discussing works primarily in terms of innovations in techne. I will come to these issues in Part 2, in the light of the key principles of a biopsychosocial approach to post-acousmatic composition (BPS_paC) that develops over the next three chapters.

1.4 Overview

As a speculative solution to the issues raised, the contributions of this research to knowledge are twofold:

1. to propose and outline a biopsychosocial (BPS) framework to ground a post-acousmatic electroacoustic music;

2. the composition of a series of original pieces that respond to this BPS approach.

The first point is developed in Part 1 of this thesis, and the second in Part 2 and the accompanying sound works. My proposal is transdisciplinary, and requires negotiating rather different territories, inhabited and constructed by different discursive regimens. For that reason, the reader will encounter a variety of terminologies and contrasting language. I have included a list of abbreviations, a glossary of key terms and additional information in the appendices at the end of this thesis.

1.4.1 Part 1: Thinking sound

Sounding, and its thinking by scholarly disciplines, complicate one another in a manner that requires engaging with questions of 'philosophical hygiene' (Sterne, 2003: 18). Chapter 2 wrests the acousmatic away from phenomenology, recuperating it as epistemic tool. It outlines recent philosophical realism, speculative aesthetics, and ontotheologies of sound as developments in composition theory, to set the context of my BPS approach. This paradigm and my model of listening is outlined in Chapter 3, which disassembles the ideal listener, approaching the listening-composing mind as a fractionable and practical rather than ideal object. The sonic realism that I advocate is grounded in the BPS psychiatric paradigm. My aim is to contribute to what Xenakis, in his doctoral defence, called an 'alloy' of scientific and arts/humanities thinking:

> […] a search for deep forms that motivate human thought processes and concrete manifestations (art, science, technology, architecture and even the evolution and perception of biological forms) (Polansky, 1990: 385).

While his was with mathematics, my alloy is music and the social and cognitive sciences (broadly defined), although I shall also draw from the mathematician and musician Guerino Mazzola.

Chapter 3 develops specific topics relevant to a biopsychosocial approach to post-acousmatic composition (BPS_paC). I propose an eliminativist 'listening without a listener'; trace as viscerality and cochlearity formed by mnemonic systems; apophenic generation; the K-matrix of musical domains; the reception-interpretation-action triple helix; and mentalizing listening stances and we-centricity formed through dual-cognitive process large-scale brain networks.

Chapter 4 takes forward this BPS_paC, unshackling sound from the constraints of 'authentic', 'musical' perception'[11]. Key ideas are the 'not-knowing' stance, mentalization of sound as motivated interiorities and evental exteriorities, chimerae as materialisations of spectrotemporal entities that transit between and transmogrify semiotic processes; the generation of new epistemic things through experimental culture; and composition as heterogeneous engineering through the construction of sonic assemblages.

1.4.2 Part 2: Sounding thinking (chimera and assemblage)

Part 2 discusses the design of several sonic assemblages. They do not neatly concretise the BPS_paC, but rather, each responds to different aspects as it developed through re-entrant circuits between sounding and thinking trace.

[11] This is discussed in Chapter 2 through a debate between Schaeffer and Xenakis.

Chapter 5 focuses on fixed concert performance and/or installation pieces. A post-acousmatic triptych, collectively titled *On the Admissibility of Sound as Music and Art*[12] deals with the transcendental listener, aesthetic regimens, and the balance between the perceptual and conceptual. It comprises three assemblages that engage an 'Islamic sonic-social'[13]. The first piece, *the bird ghost at the zaouia*[14], engages soundscape, memory of place and debates regarding religious disciplining of music and sound[15]. *Makharej* primarily addresses the 'opening' of the Arabic letters as they exit the body; the somatic places from which they are articulated, drawing equally from the traditions of Qur'anic recitations (*tilawa* and *tajwid*) and sound poetry (such as Kurt Schwitters's *Ursonate*). It questions the transcendentally ideal subject through embodiment and the impersonal world. *The Remainder* (2013) was commissioned for Maerz Musik in Berlin, and engages with theological debates in mediaeval Islamic mathematics and investigates the formalism of number and algorithmic structure to produce evental flows.

Batroun Concrète, a piece commissioned by Batroun Projects in Lebanon, is a hybrid electroacoustic/scored piece that relies on site-specific improvisation structured through body-related cognitive schemata. The early *0.0* fixed version developed into a live performance version *Batroun Concrète 2.1-2.9* that is discussed in Chapter 6, but was never fully realised as the final performance was disrupted by the beginning of the Syrian uprising; however, it is a kind of bridge between the 'aesthetic regimens' pieces and my other live pieces that draw on the discipline of improvisation structured through the design of particular hardware-software assemblages.

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12 The title discloses a link to the transcendentalism of the 11th-century Sufi mystic and theologian Al-Ghazzali (discussed in Chapter 5). His writings remain influential within Sharia debates concerning the ethical admissibility of music in religious life. He famously argued for the use of sama' (listening) linked to dhikr (remembrance of Allah); certain 'music' is halal and prayerful, subject to specific constraints.

13 This will be discussed in Chapter 5.

14 Brief explanations of these Islamic–Arabic terms are included in the glossary.

15 After *On Listening to Music* by Al-Ghazzali (2003).

Chapter 6 discusses live work, including the *m-Log* controller and three iterations of *hQi.live*, an evolving software-hardware system. It began as a conventional live sampling and electro-instrumental paradigm, but became more of an agentive partner incorporating machine listening elements, increasingly displacing the listening-composing mind in performance.

Finally, Chapter 7 evaluates the BPS framework and my application to post-acousmatic composition, outlining the current extensions of this work, and suggesting key trajectories for future developments.

Chapter 2

In the midst of it all, the disciplined ear

> Sound studies is driven by powerful forms of magical thinking, that cause us to imagine and believe improbable, contradictory and frankly absurd things about the nature and power of sound. But if sound studies are conducted in the projective or voluntarist mode of the what-if, or the if-only, this is perhaps a revealing reflex of the fact that the human experience of sound is itself so intensely phantasmogenic. To expunge the dreamwork conducted through sound altogether would be to set aside what in fact may be the most important and defining feature of our relation to sound (Connor, 2015: 9).

2.1 The authentic acousmatic, trace-image and the equanimous ear

An historic debate marks divergent sonic territorializations which has resonance today: composition through the experience of perceptual features or by events relatively autonomous of a subject. Pierre Schaeffer remarked:

> Xenakis has not taken the trouble to verify the relationships which might exist between mathematical production of sonic objects and their authentic musical perception (Schaeffer, 1970: 75).

The difference in their philosophical grounding for listening is disclosed when Schaeffer continued:

> […] without a phenomenology, and without the distinction that Xenakis has never been able to establish between sign and signal, there is no means whatsoever of warding off dreamers who wish to invent combinations of parameters without concern for characteristic features (ibid).

Schaeffer reproaches an unconstrained dreaming on two grounds. It reaches beyond the phenomenological limits of listening, and does not respect semiological codes. As akaousmatikoi and Husserlian phenomenologist, his intentional sound object is not identical with the physical material object but rather, as the correlate of a synthetic act of consciousness, it transcends any particular spatiotemporal adumbration and is freed from its empirical, factual context becoming an eidetic reduction: the sound-in-itself (Held, 2003;

Schaeffer, 1966: 263; Kane, 2007: 21)[16]. The tradition thus initiated segmented listening into categorisable morphologies to guide composition by its 'characteristic' features. Thus, his criticism reduces to the objection that if listening cannot discern a perceptual sound-in-itself, and its 'authentic' signific action, then it is not there.

The intentional object was subsequently sidestepped while preserving attention to the pertinent, salient marks of spectromorphologies, space-forms and semiotic behavioural networks, articulated compositionally through auditive experience (Chion, 1983; Chion, 1994; Delalande, 1995; Smalley, 1996; Delalande, 1998; Smalley, 2007). This acousmatic tradition diversified, constructing interrelated signs and actants, often drawing upon Jean Molino's poststructuralist semiotics of esthesis-neutral work-poiesis (Emmerson, 1986). Sounds as signs in networks of experiential meaning enter the sphere of language.

While Xenakis (as mathematikoi) advocated for logical and algebraic formalisms to organise musical symbols and sound, he was also aware of the limits presented to listening, but rejected Schaeffer's methods. Rather, what counted was the trace that sound leaves through the temporal flux of event:

> [...] what is the flux of time which passes invisibly and impalpable? In truth, we seize it only with the help of perceptive reference–events, thus indirectly, and under the condition that these reference–events be inscribed somewhere and do not disappear without leaving a trace. It would suffice that they exist in our brain, our memory [...] Indeed, the underlying postulate is that time, in the sense of an impalpable, Heraclitian flux, has signification only in relation to the person who observes, to me [...] this inscription must satisfy the condition that it be in a manner which is well circumscribed, well detached, individualised, without possible confusion. But that does not suffice to transform a phenomenon that has left traces in me into a referential phenomenon. In order that this trace–image of the phenomenon become a

[16] Husserlian phenomenology makes a distinction between 'factual' and 'intentional' objects. Factual objects include such things as state affairs or dispositions that are taken to be real, datable psychic events and investigable through scientific means such as by the discipline of psychology. Intentional objects are synthetic constructions of consciousness through which the mind is able to identify and to hold before itself 'objects' that are identically the same through a multiplicity of acts of consciousness. Such intentional objects are taken to have an objective character particular to phenomenology as a discipline, and are not psychological (Held, 2003).

> reference mark, the notion of anteriority is necessary […] It seems that the notion of separation, of bypassing, of difference, of discontinuity, which are strongly interrelated, are prerequisites to the notion of anteriority. In order for anteriority to exist, it is necessary to be able to distinguish entities, which would then make it possible to 'go' from one to the other (Xenakis, 1992: 262).

Rather than being centrally determinate for practice, auditive experience is a plastic material that sonic event marks with trace-image, registering flows and ruptures in the transforming universal flux, through which time and anteriority emerge.

While Schaeffer resected sound objects from their background as perceptual essences, John Cage cultivated attention to background. In Cageian composition, auditive experience is detached, drifting and equanimous with respect to the sounding world, opening a non-intentional, indeterminate composition. While their resulting practices were markedly divergent, like Xenakis, Cage gives credence to the flux of sounding event that is relatively independent of construction by a subject. For Cage, this flux is met with a discipline of cultivated, floating attention. For Xenakis, it is a matter of cohering trace-image, mnemonic registration of probabilities taking on 'a new cohesion capable of satisfying […] intellect as well as […] aesthetic sense' (Xenakis, 1992: 37).

2.2 Thinking and sounding

The way in which we think the relations of listening subjects and sounding objects has implications for the methods and scope of compositional action. This chapter contributes to these debates, turning around the resurgence of realism and physicalism within contemporary philosophy that has presented a challenge to '[…] the idealism and humanism that have characterized philosophy and cultural theory since the "linguistic turn"[17] ' (Cox,

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[17] In *After Finitude*, Meillassoux argues that the linguistic turn and representational realism in phenomenological, post-Saussurian continental philosophy and post-Wittgensteinian analytic philosophy, particularly post-modern thought, has greatly hampered thinking across science, philosophy and the humanities. In brief, he argues that Kant's Critiques located the formal construction of belief solely within the human subject. By grounding reason entirely upon itself, we reach a blind alley by which the physically real (broadly what Kant relegated to the category of noumenal unknowability) could never be

2011: 146). Advocating a philosophy of sonic materialism, Christoph Cox observes that sound theory has adhered to broadly linguistic tropes.

> Culture is construed as a field or system of signs that operate in complex relations of referral to other signs, subjects, and objects. […] it treats human symbolic interaction as a unique and privileged endowment from which the rest of nature is excluded. It thus accords with the deep-seated metaphysics and theology it aims to challenge, joining Platonism, Christianity, and Kantianism in maintaining that, by virtue of some special endowment (soul, spirit, mind, reason, language, etc.), human beings inhabit a privileged ontological position elevated above the natural world (ibid).

In the aftermath of speculative realism[18], such correlationist tropes, however valuable and recursively self-aware they may be on their own terms, only ever make sound in their own image, granting no access to an outside of the discursive realm.

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An exit from the 'phenomenological cul-de-sac' (Kim-Cohen, 2009: xix) usefully erodes the music/sound-art boundary, expanding the admissibility of a variety of practices and orientations and disqualifies Schaefferian sounds-in-themselves. Kim-Cohen decouples sound from an inherent 'interiority', referring to Jonathan Sterne's 'audiovisual' litany that traces back to Christian theologies, where music is typically thought as primarily immersive and affective, while the visual is an exteriority linked to thought and concept (Sterne, 2003: 15). He argues that '[…] since being human is a state inexorably tied to language, then, presumably, linguisticity is the order that obtains' (Kim-Cohen, 2009: 112, after Cox, ibid). He thus reaffirms the Kantian correlative split, the game of discursive signification and meaning.

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thought and is perpetually refracted through linguistic systems of meaning, never able to reach reality itself. See Bryant et al., 2011.

[18] This influential movement in critical art theory is now largely succeeded by terms such as 'accelerationism', 'objected-oriented philosophy' and draws broadly from other disciplines such as sociology, philosophy of science and neuroscience. They are linked by the implications of Meillassoux's critique and the central question of 'How is it possible for thought to access that which is not always-already mediated by thought?' (Mackay et al., 2014: 4). For further discussions see Bryant, Srnicek and Harman (2011), and Cox, Jaskey and Malik (2015).

Putting aside questions of what a 'sound-in-itself' may be for the moment, on Kim-Cohen's broader point I see a danger that composition might simply replicate what Suhail Malik has termed 'anarcho-realism', the post-modern malaise that contemporary art finds itself in by endlessly raising discursive questions and tautologously re-problematising without recourse to any answers outside of its own linguistic horizons (Malik, 2013).

Cox and Kim-Cohen occupy two distinct vertices that have different implications for practice. I am advocating a position, informed by a scientific materialism, that I think arbitrates the difference. It will open an entry into sound decoupled from the primacy of phenomenality and linguisticity that also expands the scope of techne conceptually and pragmatically. To initiate this trajectory, we need to tread some discursive terrain.

2.2.1 Sonic speculative aesthetics

Kim-Cohen locates sonic practices within the purview of art through a Duchampian position, emphasising the conceptual over the perceptual. However, the historic origins of art might be considered as a kind of 'hustle' taking place in the Renaissance that elevated and reified practices, allowing artisans to access status and resource (Benedict Singleton in Beech *et al.*, 2014: 48). This might be balanced by the non-institutional framing of art (pre-art as autonomous practice) recapturing that aesthetically constructed objects exert force and agency as theorised by the anthropologist Albert Gell (1998).

Thinking with Lydia Goehr (1992), DeNora (2000a, 2000b) and others, music might be understood as exerting accumulated activity with the purpose of doing something, rather than as an aesthetic regimen focusing on Kantian 'disinterested' subjectivity. Sonic arts might capture and trap the force of objects, structuring environments and constructing a 'fixity [that] can be used, quite literally, for leverage' (Benedict Singleton in Beech *et al.*, 2014: 43). Rather than distilling Platonic ideals, this invokes a Socratic method where, 'Beauty is its use … something is beautiful if it does what it's supposed to do really well' (Peter Wolfendale, ibid: 37). However, the issue of judgement remains, as we struggle to 'jump over the shadow of the subject' (Trevor Trevatt, ibid: 38).

The Duchampian model ultimately draws a 'strong distinction' between subject and object resulting in the 'final sublimation of the object by the subject' characteristic of Kantian aesthetics (ibid: 48; Shaw, 2013). We might reject this basic premise of art as the reification of subjectivity through transcendentally autonomous production. Instead, aesthetic practices, understood as the composition of objects that exert force, might reclaim the notion of a sublime through a subject that 'erupts from objects' along a 'continuum that includes the subject as part of it' (Trevor Trevatt, ibid: 38). Subjectivity is not eliminated, but instead decentred. It is not transcendent to, but contingently produced through its vectorial relation to object.

The mathematician and musician Guerino Mazzola models such vectorial relations, as the 'functor' of musical objects (Mazzola, 2002). In mathematics after the Yoneda lemma, point-of-view is not simply a position, but a perspective as a vector between perceiver and object (Yoneda, 1954, after Mazzola, 2014). Mazzola highlights the etymology of point as a puncture, created by the presemiotic (in Molino's sense) gesture of pointing. The subject position (aesthetic or otherwise) is a perspective towards an object, linking the two. The key point for this discussion is that rather than music practices being necessarily predicated on interpretive, signifying, meaning-generating activities of the perceiver (whether composer or listener), a realist position gives credence to objects as forces in their own right that are in geometric vectorial relation between subjects and objects on the same plane. I shall return to this linkage over the coming two chapters.

2.2.2 Sonic materialism

Various authors affiliated to *Urbanomics*[19] have written on sound, particularly in relation to the composers Florian Hecker and Iannis Xenakis (for example Meillassoux, 2006; Mackay, 2010; Negarestani, 2013). It is probably Cox who has been most systematic in applying the correlationist critique to sonic art, and although not a fully developed theoretical position I shall group these perspectives together as sonic materialism (Cox,

[19] A key publisher linked to speculative realism, speculative aesthetics and its various successors.

2009; Cox, 2011; Cox, 2016). Cox sites works such as Chris Kubick and Anne Walsh's *Full Metal Jackets* (2005), Kubick's *Hum Minus Human* (2012), La Monte Young's *Dream House,* Alvin Lucier's *Music on a Long Thin Wire* and works by Chris Watson and Francisco López. Stylistically it may not be quite apparent what links these practitioners, and indeed my own work. However, their orientation '… begins not from music as a set of cultural objects but from the deeper experience of sound as flux, event and effect' (Cox, 2016).

The claim is to think sound away from the primacy of interiority, meaning after Cox's usage the linguistic and humanistic, and towards exteriority, giving credence to the direct power of the sonic[20]. This is an ontology of sound effects as Deleuzian haecceities[21] or singularities, becomings of events independent of a subject:

> […] captured by verbs in the infinitive ('to cut,' 'to eat,' 'to redden,' etc.), that have no subject and are bound to no particular context. They simply describe various powers of alteration in the world, powers of becoming that are variously instantiated (ibid).

Cox cites Cageian listening as leaving sounds to operate as anonymous flows, 'that precedes and exceeds human contributions to it' (ibid), thus emphasising a materialist model of 'force, flow, and capture' (Cox, 2011: 157). The autonomy of sonority's affects emphasises the material body, and sound's activity prior to capture by linguistic signification (Cox, 2009; Cox et al., 2015). It is a:

> […] 'reductive' [and] functional approach to sound and signals wherein the aesthetic is understood to be a kind of residual congealing or crystallisation, an unavoidable by-product of more fundamental and primarily functional processes (Schrimshaw, 2013).

The approach therefore rejects standard musical philosophical positions that approach sound and music with 'a conceptual apparatus already in place', meaning a privileging of linguisticity (Cox, 2016: para 16). Sonic materialism takes seriously that sound operates as a

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20 I note that the term 'interiority' used here after Cox means the opposite of its use in Section 2.2 after Kim-Cohen. This interiority/exteriority distinction is discussed in the next chapter in the light of large-scale brain networks.

21 The property of a thing that marks it as unique. This 'effects approach' is exemplified by Jean-François Augoyard and Henry Torgue (2005) who depart from the Schaefferian objet sonore, in favour of a Deleuzian model of event, auditory effect and intensities.

material force, in excess of any subjectivity that might apprehend it. As I see it, the critique of the primacy of subjectivity is an argument to decentre the perceptual core of music's ontology.

Like both Kim-Cohen and Cox, I see these debates over the nature of subject and object as potentially deepening an understanding of sounding and listening. While I lean towards the materialist perspective, in its current formulation, I see a major deficiency in its formulation of sound and sounding. If we take the call to the real as a substantive issue, I see no value in simply bracketing out the perceptual. Rather, this phenomenality must itself become targeted, not from within its own horizons, but restructured in technoscientific terms that seek to engage this real.

2.2.3 Experience and the conditions of experience

To rethink sound through materialism, we must elaborate both sides of the correlation without privileging the discursive as its arbitrator. I suggest that clues lie within the conditions and composition of Cox's interiority understood as auditive experience.

Discussing the cacophonic work of Florian Hecker (poster boy of sonic speculative realism) T.J. Demos emphasises the 'unheard'[22] and disruption of the received 'aesthetic apparatus' by 'desubjectivization', the result of withdrawing the familiar aural environment from one's grasp' (Demos, 2010: 58; Goodman, 2010). Robin Mackay pursues a similar theme as the 'de-naturalising' of the ear (Mackay, 2010). Both are concerned with undoing received aesthetic and denotive practices. However, this practice of compositional action targeting perception and semiotic/semantic linkage is already well described in mid-20th-century composition.

The composer Helmut Lachenmann's argument for listening itself as the object of music, and the composer-cyberneticist Herbert Brün's synergistic cause and effect between

[22] This is linked to Steve Goodman's 'unsound', the ultra-low and ultra-high frequencies that lie outside of auditive experience that he discusses in *Sonic Warfare* (Goodman, 2010).

composer and listener, and anti-communication, on the face of it are profoundly oriented to sound as interiority (Lachenmann, 1980 and 2003; Brün, 1995b and 2004 (1970). Like Demos and Mackay, both seek to disrupt and exceed habitual signification. Lachenmann argues that:

> […] the immediate object of music is not the world, or the world's deterioration, which we may bemoan, laugh at, or respond to in some other rhetorical or emotional way. The object of music is listening, that is, perception perceiving itself (Lachenmann, 1980: 29).

Through an explicit reversal of folk-psychological presumptions of listening *to* music, music targets listening. It is acted upon by sonic agency and carries intentionality. Introducing a reflective loop (that does not require a philosophical phenomenological orientation), whatever music may be, its objective is to be listened to in order '… to broaden the experience of hearing rather than satisfy its expectations' (ibid: 27). This foregrounding of perceptual activity becoming self-aware may be an interiority in Cox's sense; but implicit is the acknowledgement of sonic affect and effect, and specificity beyond a subject. I suggest that affect, and (as will be developed in Section 3.3 and 3.5.1) its corollary reflection, are central to two key concepts in Lachenmann: klangstruktur and 'broken magic'.

To break the magic in music means to '[…] intervene in the sounding structure of the magical object, thus provoking us to attend closely and intensely to what really is going on in our perception' (Heathcote et al., 2010: 342). The magical is evolutionarily and historically, the default ritual use of music, which is not listened to primarily as an aesthetic object, but functions 'as an evocation of the numinosum' (ibid). Lachenmann was talking about Bach and chorales, but rave, Noise or immersive drone might be recent equivalents.

His 'broken magic' and 'klangstruktur (structure-sound)' refer to intervening into the physicality and received functions of sounds – the way in which sounds are materially produced – and how they operate on listening to disrupt established territories for sound, systems of the aesthetic apparatus. Brün's anticommunication gets at a related idea:

> I use the word 'anti-communication' whenever I wish to speak of a human relation between persons and things which emerges and is maintained through messages requiring

> and committing not yet available encoding and decoding systems or mechanisms (Brün, 1995a: 478).

Both composers are pointing towards not-knowing, an affective moment where habitually received codes are disrupted[23]. While these might be taken as a privileging of the subject, I think it carries a thread that relates to the 'practical eliminativism[24]' that Mark Fisher speaks of in relation to a speculative aesthetics, when he says:

> I want to suggest some sort of return to a Kantianism. Not to Kantian aesthetics, nor to his metaphysics and epistemology, but to the crucial difference between experience and the conditions of experience (Fisher, 2014: 92).

In broken magic, anti-communication and structure-sound, the perceiver is not by necessity transcendentally outside of the object of listening; rather, it is a becoming with the sounding, in what I will call the 'we-centricity'[25] of subject-object, listener and material sound. This happens geometrically through gesture – in the French sense that Guerino Mazzola[26] (2009) describes as presemiotic – it does not require an explicit signification or meaning, but rather is a foregrounding of the apparatus of sonic experience – shared constructions linked to felt-sensations, rather than communicable traces captured and known by language. I will say more about this in the next chapter.

In Brün's writing the composer's activities leave traces that both specify and are implicated in nested systems that produce sounding (Brün, 1995b; Brün, 2004). Like Xenakis, Brün as *kybernetikoi* advocates the listener-composer subject as pilot rather than as deterministic cause operating outside of its object. Thus, subject is contingently linked to, and emergent from music whose object is listening and so circulating back to subject. This

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[23] I return to this later in relation to salience and the recruitment of the central executive in Chapter 3.

[24] This philosophical eliminativism will be fleshed out into an account of the listener in Section 3.2.

[25] This is discussed in Section 3.5.1.

[26] After the mathematicians Henri Poincaré (1905) and Gilles Châtelet (1993), gesture is a figuration of the bodies' movements with an aim, that is, a spatiotemporal extension with a vector. Mazzola argues that such gestures are presemiotic, (with respect to the influential post-structuralist esthesic-neutral-poietic view (Molino 1990)) but can be combined to form semiotic signs. This is distinct from Anglo-Saxon approaches, such as Adam Kendon (2004), where gesture is simply a special semiotic sign.

opens the way to a systems approach to composition, which I develop in Chapter 4, through assemblage and heterogonous engineering. The specificity of the sound-itself is an integral component in the system and not transcendentally relegated to the other side of a correlation.

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I think that a sonic materialism that entirely disqualifies interiority without accounting for it becomes yet another ontotheological sharia. Of course, we can imagine practices based upon sonifying big data, pyroplastic flows, pure mathematical formalisms, or emanations from supermassive black holes (Morton, 2011) to seek only a Great Outdoors, but ultimately, if it is listened to, some sort of experience is engaged and cannot simply be bracketed out.

Within the speculative aesthetics arena, Xenakis is lauded as arch formalist, whose mathematizations typify an approach that de-emphasises or even eliminates interiority. However, during his doctoral defence, the exchange between Messiaen and Xenakis - on the theme of revelation versus inference in the arts and sciences - opens into the importance of love and emotion when 'the arts utilise highly formal process[es] of technology' (Polansky, 1990: 387). Xenakis refers to emotion as an 'epiphenomenon of knowledge'. It is a means of interpreting that selects from the immense possibility space that formal mathematical procedure presents when he says 'Listen, and if you don't understand, listen again. And then, like it, if you like it' (ibid). Ultimately, no matter what philosophical constructions one chooses to affiliate to, if the object of composition is for its results to be heard, then perception has to be accounted for. To paraphrase Xenakis, you either do or you don't.

2.3 It could be otherwise

The title of this thesis could have been 'on the pressing need to exit the acousmatic' or 'listening without a listener' or 'cognitive transparency and the adequacy of sonic arts to the demands of neurocomputational dynamics' or perhaps 'towards a materialist ontology of listening'. These would encapsulate my approach, but are vague in articulating thoughts that do work for the practical business of assembling sounds intended aesthetically.

An alternative might be 'attending to experiences in the vicinity of an auditory art object' or even 'lifting the acousmatic veil of the transcendental listener' – equally gnomic, but promising. The key thought can be put more concisely: post-acousmatic composition traces the assemblage of networks of causal interaction which may be more or less adequate to the demands of neurocomputational dynamics, in order to generate new model-based knowledge that has the rendering of cognitive opacity as a central practice that provokes reflective mental processes. The biopsychosocial reasoning behind this statement will be developed in the next chapter, but prior to that I revisit foundational philosophical positions on sound-itself: a revision of the acousmatic that paradoxically traces an exit from the extant acousmatic.

2.3.1 Post-acousmatic and Bionic not-knowing

In the Schaefferian territory, 'reduced listening' and the 'sound object' are mutually dependent, defining one another as perceptual activity and object of perception, claiming sound ontologically as an intentional object, an 'objective datum' of the sound-in-itself in its subject-givenness (Held, 2003; Connor, 2015). Brian Kane convincingly charges Schaeffer with being unable to properly attend to the relationship between techne and physis, technique and nature, by which the sound object is produced through technologies and techniques of listening (Kane, 2014). Historicising the much-discussed origins in antiquity, he reveals it as a myth used by Schaeffer to transform the loudspeaker array into a Pythagorean veil, thus obscuring the role of techne in the process. By detaching the material trace inscribed into vinyl (Schaeffer, 2012 (1952)) from the condition of its making, Schaeffer reifies the sound object, as a synthetic act of consciousness by a transcendentally ideal listener.

Kane recuperates the term 'acousmatic' via Jean-Luc Nancy, wresting it from the phenomenological baggage of Schaeffer's strong association (Nancy, 2007; Kane, 2014). Whereas Schaefferian *entendre*-as-intention structurally requires an ego, a subject:

Nancy selects écouter as the axis for his interrogation of listening because of his sensitivity to the etymology and implications of the verb entendre (Kane, 2014: 128).

He demonstrates that many sounds (like the Moodus Cave noises in Connecticut):

> [...] are neither heard primarily as aesthetic objects, nor capable of being made intelligible in aesthetic terms (ibid: 6)

The dynamic of acousmatic sound, he argues, is not a division between the senses nor even about seeing and hearing. It is fundamentally epistemological in nature, primarily about knowledge, certainty and uncertainty.

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Comparison between Schaeffer's suspensive listening and that of his contemporary, the psychoanalyst Wilfred Bion, points to the same conclusion. Bionic listening is a state of hallucinated reverie, a place "without memory, desire or understanding" where objects luminesce in a beam of intense darkness (Casement, 1990). Listening with memory is intent on making its object part of an old agenda; with desire, part of a new one. To avoid premature knowing, listening cultivates a 'not-knowing stance', operating through dynamic mental transformations; a set of geometric relations between vertices in a relational matrix which are shown schematically in Figure 2 (Bion, 1961 and 1965; Lopez-Corvo, 2005).

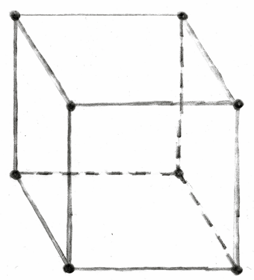

Figure 2: A matrix showing vertices of projection (after Bion, 1961)

The complexity of Bion's object-relational thinking is beyond the scope here, however, key points are germane[27]. While Kantian in its origins, limitations of that perspective 'led

[27] Bion revolutionised British psychoanalysis with a focus on thinking rather than hermeneutic interpretation (I recommend Grotstein, 2007; Reiner, 2012 and Ferro and Forresti, 2013). The Glossary

Bion to go beyond its confines' (Lipgar and Pines, 2002: 229). His early psychoanalytic approach to a biopsychosocial perspective is introduced here, but the later more developed paradigm is briefly outlined in Chapter 3.

In the analytic dyad, each subject is also an object for the other. These subject/objects are themselves composed of groups of sub-personal object-relations (elements within the psyche that operate unconsciously and largely autonomously that fuse representations of external realities with internal affectively charged elements – see Glossary: Object Relations). Figure 2 can then be read as object-relations within a subject, and/or operating across the dyad. The matrix applies to groups by placing a subject at each vertex[28], resulting in a proliferating relational network of 'projective geometries' (Bion, 1961). Through a scaling function[29], a vertex might be occupied by a particular group, a community, an institution, up to a society that is enmeshed in reciprocal systems effects (Torres and Hinshelwood, 2013).

Bion's wakeful dreaming is tolerant of the accumulations and contradictions that conjoin objects, and of the frustrations of not-knowing, of not saturating listening with presupposition. This linkage may intersect with language, but resides principally in the traces of embodied experience[30]. Like Kane's recuperated acousmatic, Bion's suspensive listening is an epistemic tool for linking (Bion, 1958). My first move towards the post-acousmatic is therefore the acousmatic, not as phenomenological reduction, but as epistemic tool, a 'not-knowing' stance that geometrically links objects and subjects.

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outlines his idea of vertex and object-relations. His thinking is foundational to Mentalization Theory which I discuss in Chapter 3.

[28] See Glossary: Vertex.

[29] This kind of scaling is in common with William Benzon's 'structural coupling' discussed in Chapter 3, and Delalande's 'assemblage' discussed in Chapter 4.

[30] In Chapter 3 I discuss Stephen Koelsch's matrix which proposes a non-conceptual musicogenic meaning that resides in this embodied relationship between listener and music.

2.3.2 Event, medium and perceiver

In the *Relational Event View,* sound arises as a tri-relation between the contingencies of disturbance events, a medium and perceivers:

> Particular sounds are events. Sounds take time and involve change – at a minimum they begin, and usually they end. A number of qualitatively different stages or a single tone of uniform loudness may compose a sound. The sounds are the events in which a medium is disturbed or changed or set into motion in a wave-like way by the motions of bodies. Events such as collisions and vibrations of objects cause the sound events. Among the effects of sounds may be sound waves propagating through a medium and the auditory experiences of perceivers. Medium–disturbing events are what we hear to have particular pitch, timbre, loudness, and location. A body counts as in a state of sounding – making a noise – just in case it is in the midst of generating or causing a particular sound. Whenever there is a sound, there is a sounding (O'Callaghan, 2009: 36).

Sounds have three characteristics:

1. A causal source – an event caused by an interaction of bodies e.g. a heavy door slamming shut;

2. Spatiotemporal continuity – the sound is caused by an event located in space and time and received by a perceiver, e.g. the door is heard in the Sultan Hassan, Cairo[31];

3. Qualitative change – sounds have duration and may perceptibly change over time from beginning to end, e.g. the causal-door sound decays in a reverberant tomb.

O'Callaghan's perspective suggests an approach to composition where the terms are on the same ontological plane of matter-in-motion: the organisation of material causal sources (compositional techne); the manipulation of the shared medium[32]; and, the organisation of the perceiver (e.g. switching attentional focus in composed listening, or the more speculative ideas that I come to in section 4.4). Events imprint traces into material brains that generate

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[31] This particular causal source takes on compositional significance at 6'17" in *the bird ghost at the zaouia*.

[32] The medium, for practical reasons is air, but others are possible and under explored. For examples, see the *Wet Sounds* project, an underwater sound art gallery (Cahen, 2011), and Chris Watson's contrastive recordings of the experience of listening in air and ocean in *Oceanus Pacifica* (Watson, 2007).

listener perspectives emergently on the basis of perceptible differences. This perceiving-brain is a differential engine in spatial-temporal continuity with causal-events. The work of the composer materialises the contingencies of sound into the present, co-organising qualitative change with the contingencies of material causal-events.

2.3.3 Disassembling the ideal listener

The composer Agostino Di Scipio's argument for a re-examination of the epistemic frameworks by which we think electroacoustic music in effect raises questions about the composition of causal-events and their reception by a perceiver:

> There are two main points to examine in order to develop a critique of these [historical and hermeneutic] methods and a renewed music–theoretical line of research. One refers to the unavoidable – but too often evaded – dialectic between the conceptual and the perceptual in musical experience. This is actually an issue of theoretical cognitive musicology, with repercussions in research work: to accept that music is not only a matter of perception but also one of conceptual constructs. This prompts the need for a relativisation of the 'ideal listener' as epistemic subject. Here I will not explicitly address this point. The other point refers to the problem of techne i.e. to the realm of techniques and technology captured in the creative process of music composition (Di Scipio, 1995: 370–1).

This relation between conceptual and perceptual is the impetus behind Kim-Cohen's *In the Blink of an Ear*. I do not agree that it can be relegated to a 'cognitive musicology'. Pursuing Di Scipio's posed but unanswered point, the relativisation of the listener has been the major focus of my theoretical work, leveraging insights from an array of sciences. His critique resonates with my discussion here of the limits of theories of signification operating transcendently outside of sound and sounding events. Di Scipio's argument is for:

> […] models, representations, and knowledge-level strategies […] understood as traces of cognitive and aesthetic paradigms specific to the medium (ibid: 369).

The medium being sound as a tri-relative, I agree that we require:

> […] a particular manifestations of a broader differential field: the field of nature and matter themselves. Only by way of such a materialist, realist account will we be able to theorize the sonic arts, and to raise such a theory to the level of sophistication characteristic of literary theory and theories of the visual arts […] such a theory of sound enjoins us to

abandon the idealist and humanist language of representation and signification […], and to reconceive aesthetic production and reception via a materialist model of force, flow, and capture (Cox, 2011: 157).

In objecting to the transcendentally ideal subject, the philosopher Reza Negarestani suggests that:

> Disassembling the possibility of the mind in terms of its givenness and reassembling it in functional terms signals the possibility of realising the mind outside of the image of what it was supposed to be, outside of where it was supposed to be embedded, and diversions from the destination it was supposed or imagined to aim at (Negarestani, 2014: para 7).

In the next chapter I introduce the biopsychosocial paradigm and an account of the listening-composing mind, as such a disassembled and functional, rather than ideal object.

2.4 Summary and questions

How sound theory models phenomenal appearances and noumenal emanations constructs the territories of compositional discourse and practice. The Schaefferian acousmatic tradition prizes the perceptual and semiotic as the ideal focus of compositional practice, believing that the sound-in-itself speaks, grounded in a listening that transcends its object. I bracket this with soundscape and acoustic ecological approaches that also emphasise sound as perceived and understood by the individual (Truax, 1999). As key authoritative discourses, both are predicated on the construction of sound via human phenomenality, by a sovereign Cartesian subject.

Kim-Cohen argues that sonic art benefits by orienting towards a Duchampian conceptual model that engages ramified networks of signification. Such practices are held to be circumscribed by linguistic representation. Composition then reifies and explores subjectivity through the varied humanist discursive methods that are now established. This might generalise sound theory away from music as an absolute or autonomous art and make contact with wider cultural thinking.

A resurgent philosophical realism has initiated the closely related perspectives of sonic speculative realism, speculative aesthetics and sonic materialism. Rather than human experience being centrally constructive of sonic art through listening, the perceptual and subjective is decentred (or even eliminated) from the core of music's ontology. Such sonic materialism is concerned with effects through vectorial relations with anonymous material events, affects, flows, forces and ruptures in a transforming universal flux. Art objects are active agents from which subjectivity might erupt.

I see two main flaws in current sonic materialism. Firstly, simply de-emphasising or even eliminating experience in favour of evental flows and exteriority does not account for, and resolve the split between both sides of the Kantian correlation. I think the aesthetic experiences of audiences, sound artists and composers as agentive presences are not adequately understood as 'residual congealing or crystallisation'. However, I avoid any special status for this experience outside of a materialist origination.

Secondly, while declaiming the limits of language and sign, sonic materialism remains largely in the discursive realm. The empirical methodologies that its orientation to sciences announces are missing: tractable hypothesising, quantitative evidence, empirical testing, statistical analysis and such like. We would not ordinarily expect composers and philosophers to undertake such research, but EAM has an historic intellectual permeability that does at least acknowledge, if not fully engage these findings[33]. I suggest that a clarifying reduction of theory through empirical evidence is helpful. By wielding Occam's razor, we might avoid discursive proliferation that risks further ventriloquizing of sound. This is not to seek to shut down thinking sound, but to refine and broaden its scope and depth.

My proposed biopsychosocial post-acousmatic modelling moves towards answering these flaws by applying wider cultural and technosocial scientific developments to arbitrate philosophical-compositional disputes outside of appeal to the simply discursive. This might

[33] I have in mind scientific figures such as such as Albert Bregman and Hermann von Helmholtz which have permeated electroacoustic discourse (Helmholtz, 1895; Bregman, 1990). Such contact has usefully informed digital signal processing and sound design, spectromorphological thinking, and approaches to sonic spatialisation, to give just three examples.

elucidate principles and mechanisms that do useful work for the pragmatic business of compositional techne.

❊

This discussion raises a series of related questions towards which a BPS approach might contribute solutions, and which will carry forward into the coming chapter. The implications for a biopsychosocial approach to post-acousmatic composition (BPS_paC) as practice are further developed in Part 2.

1. How might a BPS_paC think the listener-subject (be they composer or audience) and music- object relation? Does a 'geometric vectorial relation between subjects and eruptive objects on the same plane' mean anything beyond colourful metaphors?

2. Is auditory perception equivalent to the Schaefferian account? Does music have semiotic or semantic properties, or are these terms metaphorically borrowed from language? What is the nature and functions of mnemonic traces? Is the reception and composition of sonic arts necessarily circumscribed by systems of representation, linguisticity and discourse? Do we access sonic realities beyond how we might represent, know, speak of, or assign significance to them? Is there validity to thinking events, affects, flows and so on, anonymously outside of a subject that experiences?

3. What might constitute an interiority/exteriority distinction? Is it simply a matter of how different authors choose to define it?

Perhaps the most salient question for practice-based research is the applicability to composition. While the next two chapters approach these questions through a theoretical trajectory, Part 2 moves from the other direction, from practices of composing and sounding.

Chapter 3

A biopsychosocial approach to post-acousmatic composition

> If we want to expand artistic horizons and foster creativity there is no better approach than improving our understanding of how minds work (Huron, 2006: ix).

3.1 In the flesh of the post-acousmatic

This chapter approaches the experience of the listening-composing mind via its biopsychosocial conditions, engaging areas removed from traditional compositional territories. A fully articulated account requires disciplinary methodologies beyond the scope of a practice-based thesis which I will present elsewhere. Here, I hope to demonstrate its relevance, potential scope and utility in relation to the philosophical-compositional debates of Chapter 2.

I briefly introduce the BPS paradigm and outline Stephen Koelsch's neurocognitive model of music – which I adapt and call the 'K-matrix' – to structure the later discussions. Section 3.1.3 offers a contextualising summary to introduce my orientation to the listening-composing mind-brain. I then offer an alternative to the transcendentally ideal listener, and discuss the nature of auditory perception and mnemonic traces, linguisticity and semiotics in music, and consider the basis of an interiority–exteriority distinction. I have omitted my systematic evaluation of the relevant literatures, and focus on breadth and generality rather than the depth and complexity of each topic.

The writing takes on a terser register to cover key terrains within the space available. key research findings are summarised into diagrams and boxes. The final summary draws out some 'knowledge–level strategies' yielding tools, concepts and models to inform a BPS_paC that are carried into Chapter 4 (Di Scipio, 1995: 369).

3.1.1 The BPS paradigm

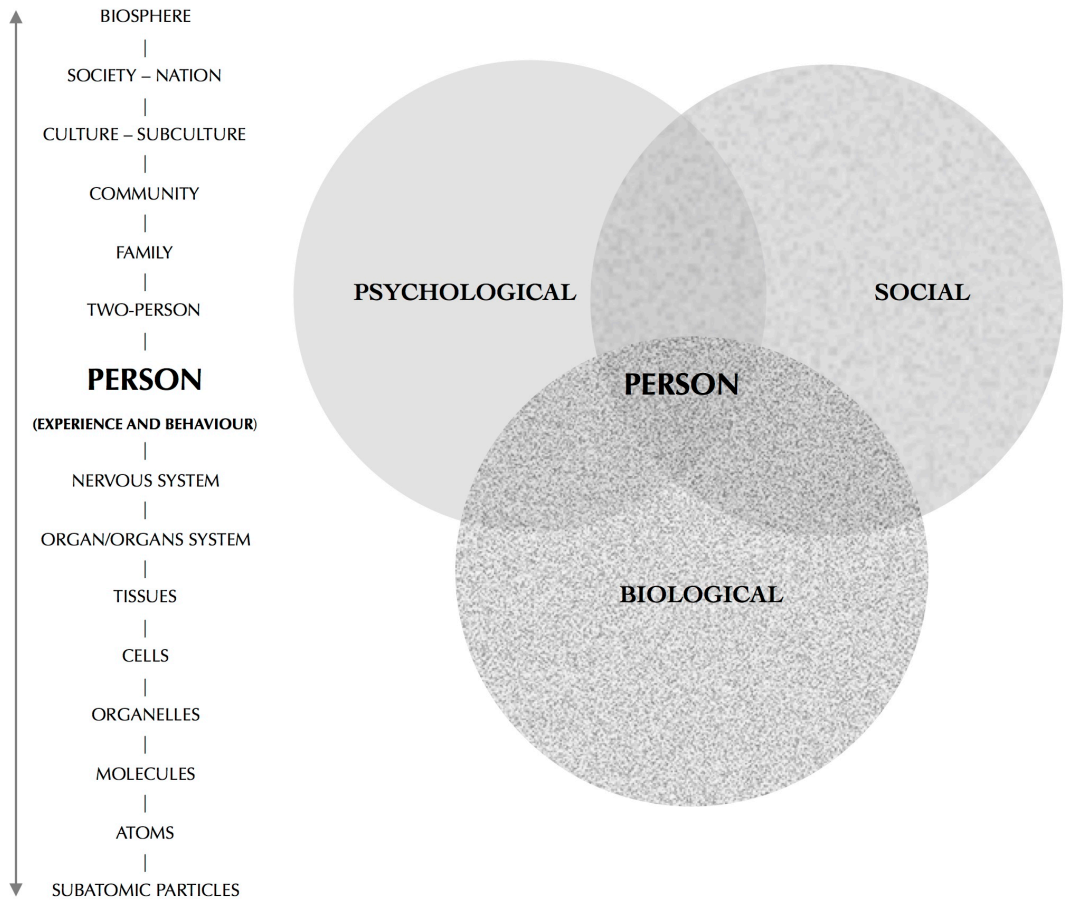

Figure 3: Biopsychosocial natural systems (left) hierarchical view (right) Venn diagram view (adapted from Cohen and Clark, 2010)

Music is possibly the most complex of human activities and it has a biological basis (Weinberger, 2004; Koelsch, 2013). The BPS approach (as developed by George Engel and John Romano), arose in medicine as a critique of both biological and psychological reductionism, offering an integrative and extensible paradigm through systems interactions between three mutually determining organisational levels: the biological, the psychological and the social[34] (Engel, 1977; Borrell-Carrió et al., 2004; Torres and Hinshelwood, 2013).

[34] The BPS perspective emphasises contingencies and provisionality and is open to re-evaluation in the light of new developments (Popper, 1959; Kuhn, 1962). It is therefore always in progress, necessarily pragmatic, transdisciplinary and extendable, such that as new findings arise they can be incorporated and even revise aspects of the whole framework.

This powerful approach to multi-factorial aetiology combines networks of interactions that contribute to an end-state[35]. In this case, post-acousmatic composition.

Figure 3 shows the BPS natural systems. Scientific methods relevant to the different domains establish mechanisms of interaction, and directions of causation. The psychological and social domains are not de facto assumed to be epiphenomena reducible to biological correlates, although phenomena are best understood at the lowest level of natural systems (e.g. the nervous system or cultural).

3.1.2 Introducing the K-matrix: musical domains and dimensions

Domain \ Dimension	A	B	C	D	E	F	G	
				Abstractions				
	opening	formation	content	combination	coordination	integration	system	
1 **Perceptual**	feature extraction	Gestalten ASA regularity	**auditory object**	structure building	structural reanalysis	vitalisation	premotor, immune system	
2 **Syntactic**	element extraction	knowledge – free structuring	musical expectancy formation	structure building	structural reanalysis	syntactic integration	large-scale structuring	
3 **Semantic**		**sign quality**				**musicogenic-**		
	iconic	indexical	symbolic	intra-musical	physical	emotional	personal	
4 **Intra-musical**	buildup of structure	stability of structure	extent of structure	structural breach	post- breach structure	resolution	(large-scale) relation	
5 **Action**	action goal	program formation	motor commands efference copies	differentiation (relating)	correction	integration	perception of action effect	
6 **Social**	contact	social cognition	co-pathy	communication	coordination	cooperation	social cohesion	spiritual
					Mentalization			
7 **Emotion**	evaluation	contagion	memory	expectancy	imagination	understanding	social functions, aesthetics	

Figure 4: The K-matrix: a systematic overview of the processes and concepts involved in music (developed from Koelsch, 2013: 250)

Musicking may be disassembled. My 'K-matrix' (shown in Figure 4) derives from Stefan Koelsch (2013) who proposes fundamental dimensions and domains for music by summarising neurophysiological studies that tease apart discrete cognitive operations some of which are specific to music, while others are more general. While predicated on Western

35 See Gilbert (2002).

tonal traditions, the model addresses some 20th-century non-tonal practices, computer music, and ethnomusicological considerations, with the intention of cultural generalisability. This raises questions of ecological and construct validity, but given the absence of such studies directly addressing EAM, it is a useful initial structure for a BPS_paC which I develop chiefly from Section 3.3 onwards.

The K-matrix cascades from top left to bottom right. Musical domains are arranged vertically in rows, and their associated dimensions feed forward horizontally across the columns, with earlier processing stages placed towards the left. The domains are distinct but there is interdetermination between them. In my adaptation, [C1] 'interval analysis' is generalised to 'auditory object' (AO) which is discussed in Section 3.3. Section 3.4 addresses meaning (as conceptual semantic signs and non-conceptual musicogenic aspects) in relation to the debates on perception, concept and linguisticity raised in Chapter 2. Section 3.5 addresses gestural mimesis and inter-individual music-social cognition through theory of mind networks ([B–G6] and [B–G7]) which I will discuss in relation to mentalization (connecting thoughts, emotions and intersubjectivity).

A key feature of the K-matrix is that dimensionally, the latter stages of perception ([E1, F1]) overlap with the early stages of the action domain ([A5, B5) through a common neural coding format. In this discussion, I will not engage the dimensional aspects of the K-matrix in any detail; however, it is worth noting that column C refers primarily to the 'content' of memory systems, which is fundamental to my overarching concept of sound's trace, the material residue that sound leaves in us (discussed primarily in Section 3.3.3). The later dimensions broadly follow a sequence where processing stages 'combine', 'coordinate' (that is become organised in various mutually determining ways) and 'integrate' to generate wider systemic effects, such as within the biosystem ([G1, 2, 3, 5]), across a piece of music ([G4]), and/or across interpersonal group social processes ([G 6, 7]).

3.1.3 A summative BPS account of the listening mind-brain

The Pythagorean extramissive ear had currency until being displaced by Bell and Magendie's separation of affector-sensory from effector-motor systems (Stelmack 2004; de Cheveigné 2006). A consequence was that the linkage between perception, cognition, affect, action and environment was obscured, a reappreciation of which is now being recovered in the cognitive sciences.

Hearing crucially places and orients us in a world. Event detection, self-alignment, motion and hearing share somatic lineages with other vertebrates, co-evolving with pre-human ancestral soundscapes (Fay and Popper, 2000; de Cheveigné, 2006; Meschiari, 2009; Shellard et al., 2010). The ear deals with the invisible and the remote, as the complement of vision. Over evolutionary time the auditory decoupled from motor systems through the interposition of flexible cognitions that refined responses to sound through thinking and emotion (Habibi and Damasio, 2014). As specifically social and linguistic primates, our embodied minds evolved to cope not only with hostile forces in nature, but also with co-operative, competitive and deceitful others (Alexander, 1989; Fonagy et al., 2002). The ear, the mind and the socio-political interpenetrate. Hence (in Part 2), I find it compositionally useful to think the trace of sound as 'an artefact of the messy and political human sphere' (Sterne, 2003: 13). I take Jonathan Sterne's statement as a shorthand for music understood anthropologically as a mental state attractor embedded within sociality:

> […] what music symbolises is an altered state of consciousness, be it a transition from one status to another, the adoption of a ritual attitude, or the acting out of personal or social importance in the face of tensions implicit in the social structure. In all cases music is directed at areas regarded as uncertain […] music tends to occur at points of conflict, uncertainty, or stress within the social fabric' (McLeod, 1974: 113, after Cross, 2015).

Figure 5 diagrams my summative BPS model of the individual listener-composer. The discrete biological body is in continuity with psychological functions and social processes. Two receptive routes for sound are shown: 'cochleal' and 'visceral' trace.

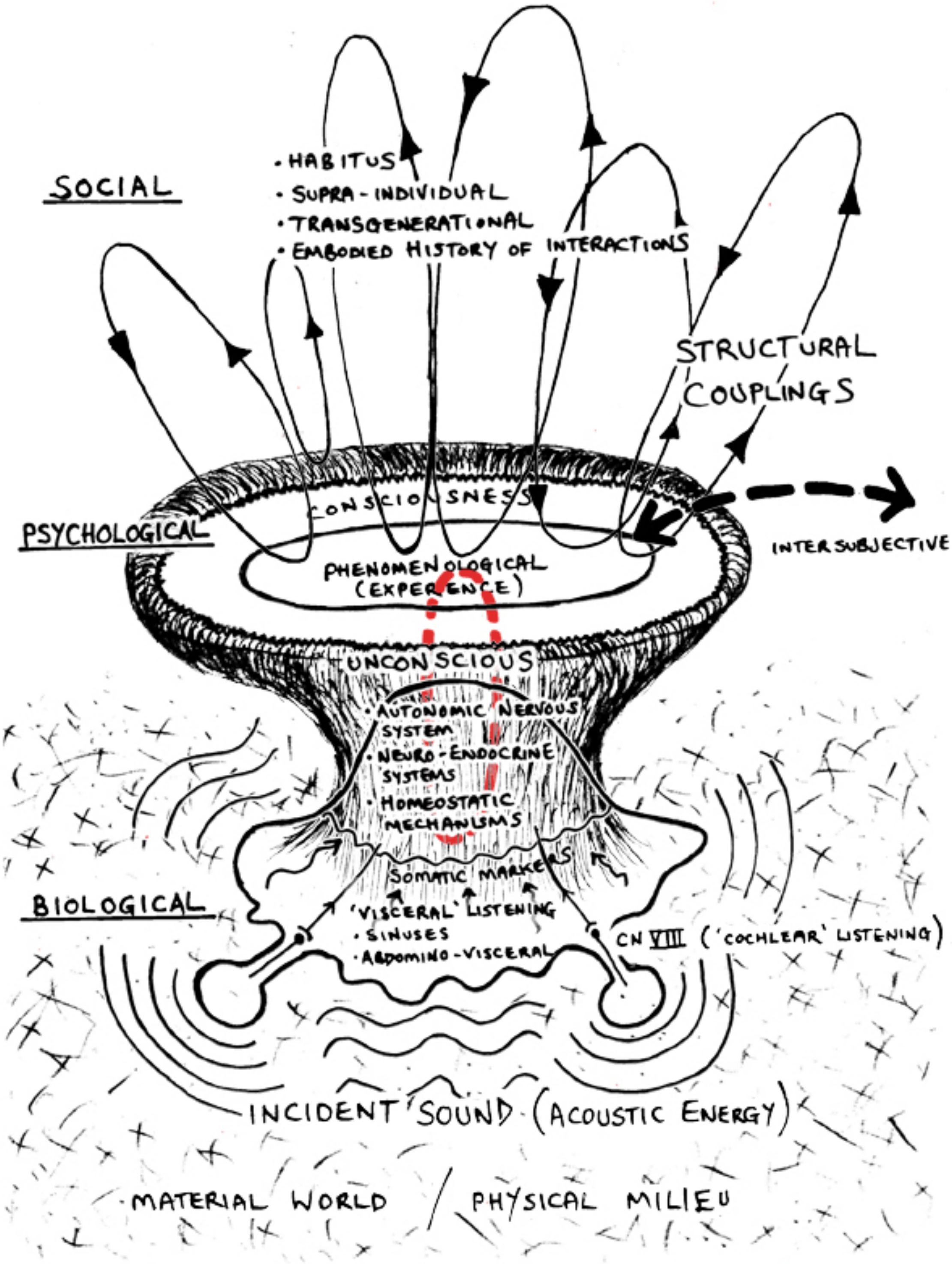

Figure 5: Diagramming the biopsychosocial conditions of individual listening

The cochlear nerves (CNVIII) capture exteroceptively originated biosignal, synapsing towards consciousness at the auditory cortices (in Figures 6 and 7). In the unconscious mid-brain, it ramifies with interoceptive visceral signal generated by sound interacting with liferegulating homeostatic processes (neuroendocrine and autonomic nervous systems) forming somatic markers that crucially contribute to musical emotion, signification and consciousness (Damasio et al., 1996; Damasio, 1999; Habibi and Damasio, 2014).

As an introspectable subset of consciousness, phenomenological experience is shown as a discrete disk. The arrowed loops indicate structural couplings with socio-cultural processes (Benzon, 2001: 23). Coupling (such as through rhythmic entrainment) is a linkage mechanism where:

> […] two or more oscillating components of one body has the same dynamics as that displayed by the coupling between oscillating components of two or more different bodies (ibid: 50).

Benzon demonstrates that the concept scales and generalises, like Bion's matrix introduced in Section 2.4, operating between the nervous system of a listener with acoustic waves; between coherent neural arrays; between the brains of groups of musicants forming shared intentions; the dynamics of groups within a community and so on.

The bidirectional dotted arrow shows intersubjective processes such as entrainment, mimetic gesture and shared intentionality (Knoblich and Sebanz, 2008; Becker, 2012). As will be discussed in Section 3.5, they are related to empathy through the interpersonal neural-social manifold afforded by mirror-neurone assemblies (Gallese, 2003; Gallese, 2009; Overy and Molnar-Szakacs, 2009). This intersubjective manifold is key to social organisation. Supra-individual socio-cultural processes may be transgenerational and embody our history of interactions (such as material cultural artefacts) and habitus[36] (Ingold, 1999; Becker, 2001; Becker, 2004).

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[36] The anthropologist Judith Becker takes up Bordieu's term as a theoretical alternative to 'culture' which is too static. She develops 'listening habitus' as 'an embodied pattern of action and reaction, in which we are not fully conscious of why we do what we do; not totally determined, but a tendency to behave in a certain way" (2004: 71). An apparently naturalised listening stance is actually generated by place, time and the context of shared culture, as well as personal biography. This is discussed further in Chapter 6 in relation to live assemblages.

The experiencing subject is emergent within BPS systems. The dotted red ellipse indicates the circularity of embodiment between introspective experience and the biological and social domains (Varela et al., 1991: xv; Varela and Shear, 1999). We are discrete information-processing biosystems that generate the experience of listening from the perspectives of our own biology, developmental history, and in the contexts of situated, embodied, culturally and historically conditioned perspectives. We are predisposed to mentalize through an 'interpersonal interpretive stance' (Bogdan, 1997, after Fonagy *et al.*, 2002: 56). That is, to imaginatively experience and understand the social (musical) world in terms of interiorities, which are mental states such as needs, desires, feelings, beliefs, goals, purposes and reasons. Music arose in relation to language and community, as a form of group affect regulation linked to social cognitive capacities (Mithen, 2006; Patel, 2008; Habibi and Damasio, 2014). Our self-constructions are themselves end points of social-physiological interactions rooted in evolved regulatory systems (Panksepp, 1998). These perceptual-affective-cognitive-motoric systems are embedded within material environments coevolved with socio-cultural systems.

3.2 Listening without a listener

I propose an eliminativist account of the listening-composing mind and sound relation, as variably transparent access to representational processes within the human biosystem. This derives from the neurophilosopher Thomas Metzinger, who gives an image of consciousness as an ego tunnel. Like Plato's cave, a neural fire throws sensory shadows onto the walls. Extending in time, the cave becomes a tunnel, a narrow trajectory through the material world, generating and confining the experiencing 'self' (Metzinger 2009). There is no one there – no denizen in the tunnel, nor listener that is listening.

In Metzinger's Phenomenal Model of the Intentionality Relationship (PMIR), '… a conscious mental model and its content is an ongoing, episodic subject-object relation' (Metzinger, 2004b: 411). The PMIR is a modelling of reality (such as a sounding world), a neural simulation within which the 'self' (a listening-composing mind) is itself modelled as a

Phenomenal Self-Model (PSM). Phenomenal events integrated into the PMIR and PSM are experienced as taking place in a world and within a self, constructing a self-world boundary within this model. This process eradicates itself at the phenomenal level. Neural processing takes time (in the order of milliseconds) through a standing context re-entrant loop[37] (LeDoux, 1996; Panksepp, 1998). The temporal dynamics of these processes, operating over contiguous chunks of now, allow us to treat these time slices as objects[38], especially when their content properties show some invariance over time (Metzinger, 2004a: 23). This generates 'inwardness' or 'interiority' through which we have ownership of a first-person perspective (Metzinger, 2004a). We experience the world transparently through this neural machinery.

> Transparency is a special form of darkness[39]. With regard to the phenomenology of visual experience transparency means that we are not able to see something because it is transparent. We do not see the window, but only the bird flying by[40]. The negative fact that we don't see the medium, the window, is itself not explicitly represented in the seeing process itself (Metzinger, 2003: 358).

Full transparency signals the unavailability of attentional access to early processing stages. Opacity is its corollary. As attentional resources are engaged[41], we have experiences that are subjectively experienced as representational processes, '[…] notably consciously experienced thoughts, but also some types of emotions, pseudo-hallucinations or lucid dreams' (ibid: 359).

Recall that in Section 2.3.1, Bionic listening is a special darkness, a kind of voluntarist ignorance, which by not-knowing, by not linking in advance, gets at the same notion. By disciplining listening to remain unsaturated by presupposition, we might become more

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[37] See Appendix 2, Figure A2.01.

[38] The formation of specifically auditory objects is discussed in Section 3.3.

[39] In Chapter 5 I discuss my solo show *Listening through a Beam of Intense Darkness*. The title derives from this eliminativist account, and from Bionic listening as a post-acousmatic epistemic 'not-knowing'.

[40] Such birds also have symbolic-cultural meanings and appear again when I discuss *the bird ghost at the zaouia* in Chapter 5.

[41] The mechanisms for this process are diagrammed in Section 3.5.

explicitly aware (i.e. engage introspective attention) of representational linkages, of the processes by which we build signification and knowledge, rather than remaining simply implicit, and by-and-large transparently given.

In the light of this, we can revisit the Schaefferian acousmatic by making a content–vehicle distinction. Both the sound object and its eidetic reduction are first-person phenomenal contents (PCs) of consciousness, the way that sound and listening might seem from an interiority. PCs supervene upon neural correlates of consciousness (NCCs), as functional properties of neurodynamic patterns.

We may have a PC which is not true of the world – auditory hallucinations are PCs, but do not equate to external perception[42]. This has implications for how we construct reality, and subjects.

> Appearance truly is an internal phenomenon, determined by functional roles exclusively realised by internal states of our brains. This is why consciousness is only appearance (Metzinger, 2004a: 68).

Subjects (such as listener-composers) are not something that we find out in the world, they are appearances, but generated by contact with something, equating to personhood that arises in societies through the development of shared and normative contexts. Like all PCs, they arise in consciousness, which is an interface that binds complex sub-processes into 'higher levels of flexibility, selectivity and globalized context-sensitivity' (idem). Things (such as sounds) may appear to have the same PC because they are functionally indistinguishable to introspection.

Phenomenal states, such as sound objects, are not solid theoretical or materially real entities. They cannot be taken as a ground for objectivity and the basis for theoretical analysis, as is the claim in Schaefferian correlationism. Rather, these PCs are themselves integrated into a dynamic and complex world-model which contains a simulation of a present sound and also the simulation of a listener that is in the act of listening (Metzinger, 2004b;

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[42] Veridicality is discussed further in 'apophenic mode' in Section 3.3.

Metzinger, 2009). While the listening-composing PSM might attempt a reduced listening, this gives no access to the material vehicle of listening itself independent of its apparent content to auditive awareness. Thus, while it might offer an interesting intellectual exercise, I suggest that it has no credibility as an 'objective datum' or perceptual essence. It gives no access to sounds-in-themselves, only the perspective that a given listener has in relation to sound. I think this suggests a certain caution in how we attributively code sound, what we ascribe to it, how we ventriloquise it through discourse. This is not to dismiss the importance of a first-person experience of listening, but rather, to recognise that such listenings are multiple and I suggest, should not be confined by authoritative sonic discourse.

❊

Metzinger discusses the mind, conceived as a biological machine, in terms of teleofunctionalism: representational states directed towards goals and consequences. These mental states are pragmatic functions which have causal properties, such as cooperating with other human beings to make music. They are tools, instruments or even weapons used by biosystems (Metzinger 2004b: 273). My eliminativist perspective is then not concerned with any perceptual essences, but with what listening reveals to a biosystem in terms of its potential use-value, what it might afford instrumentally and agentively in terms of potential for action, effect and consequence.

3.3 Sound's trace: the perceptual, the mnemonic, the syntactic

In Chapter 1, I suggested that all we can communicate of our experience of sound is the traces it leaves. Traces are sound's representations, tools that a listener-composer PSM might use. Sound's trace is neither a Schaefferian sound object, nor the material-acoustic real. It has visceral and cochleal components and speciates according to memory systems. The basis of this claim is outlined here.

3.3.1 Diagramming the ear-brain: perceptual and mnemonic systems

The perceptual domain is a pre-requisite for the other domains and dimensions of the K-matrix. Four boxes and diagrams summarise the human auditory system in this section (supporting neurophysiological details are discussed in Appendix A2, Figures A2:01 –04).

Trace is a function of auditory biosignal (shown in Figures 6 and 7) constructed via what I term the 'sonic surface' (see Box 1). There are two main corporeal routes, which I term 'viscerality' and 'cochlearity'. They are separable but integrated at the auditory cortices into auditory objects (AOs). The persistence of the perceptual as trace is a function of memory systems (see Figures 8 and 9).

Neurocomputational modelling, organised around predictive coding and Bayesian processing, suggests that perception and inference form part of a single, hierarchically organised modelling system, selecting between future-orientated competing 'interpretations' to generate an iterative best fit (Alderson-Day et al., 2016: 112–3). This is the formation of AOs whose main features are given in Box 2 (Patterson et al., 1995; Kubovy and Van Valkenburg, 2001; Shamma, 2001; Griffiths and Warren, 2004; Hegde, 2005; de Cheveigné, 2006; Winkler et al., 2009; Denham, 2012; Bizley and Cohen, 2013). The later stages of perception intersect with the earliest stages of action through premotor cortical 'common coding' (Prinz, 1990 after Koelsch, 2013: 186).

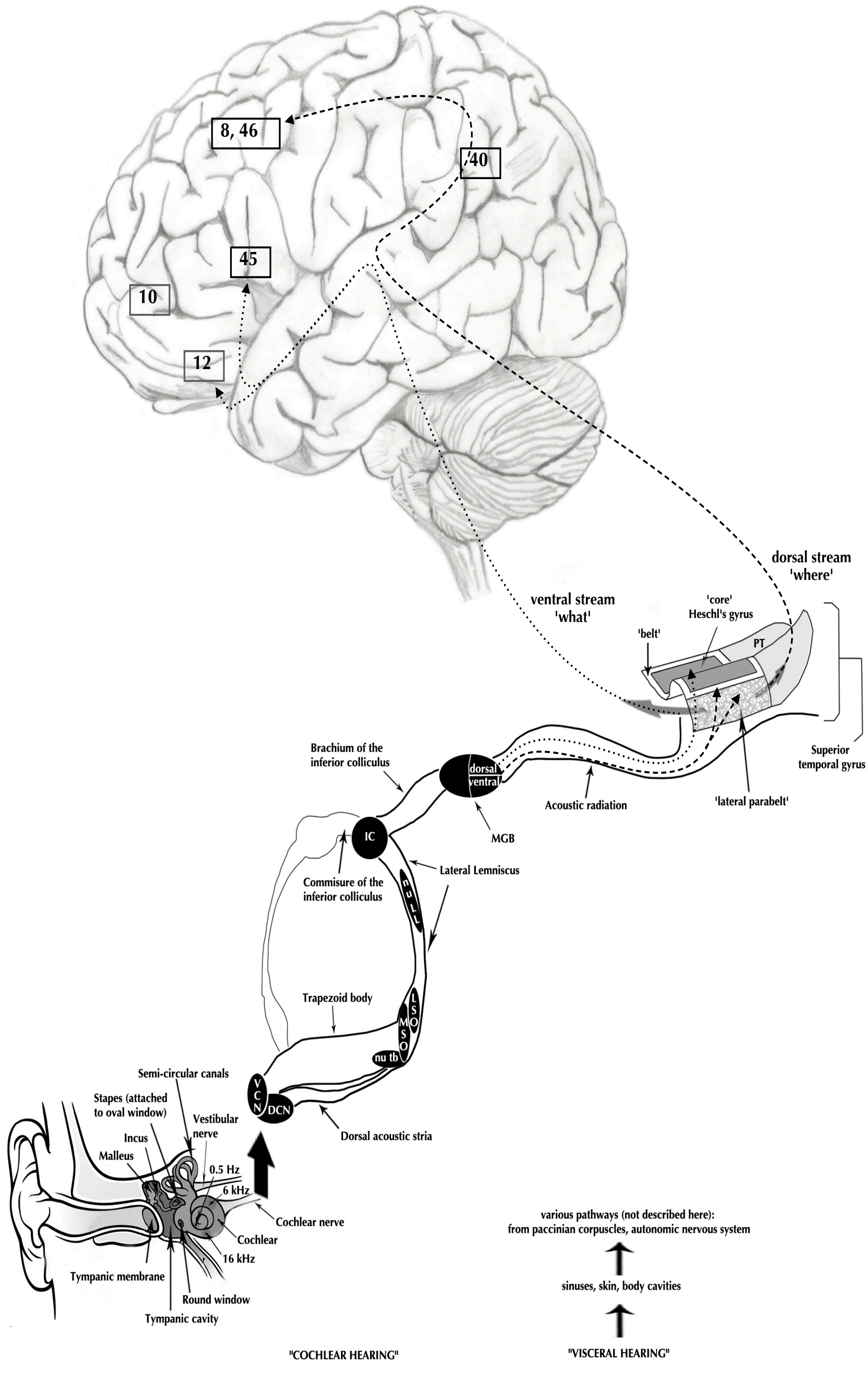

Figure 6: Anatomical view of ascending human auditory pathway. The numbers refer to Brodmann Areas and are discussed in Appendix A2.03 (after Bear et al., 2006: 364; Nieuwenhuys et al., 2008: 733–50; Malmierca and Hackett, 2010: 26). AC (auditory cortex).

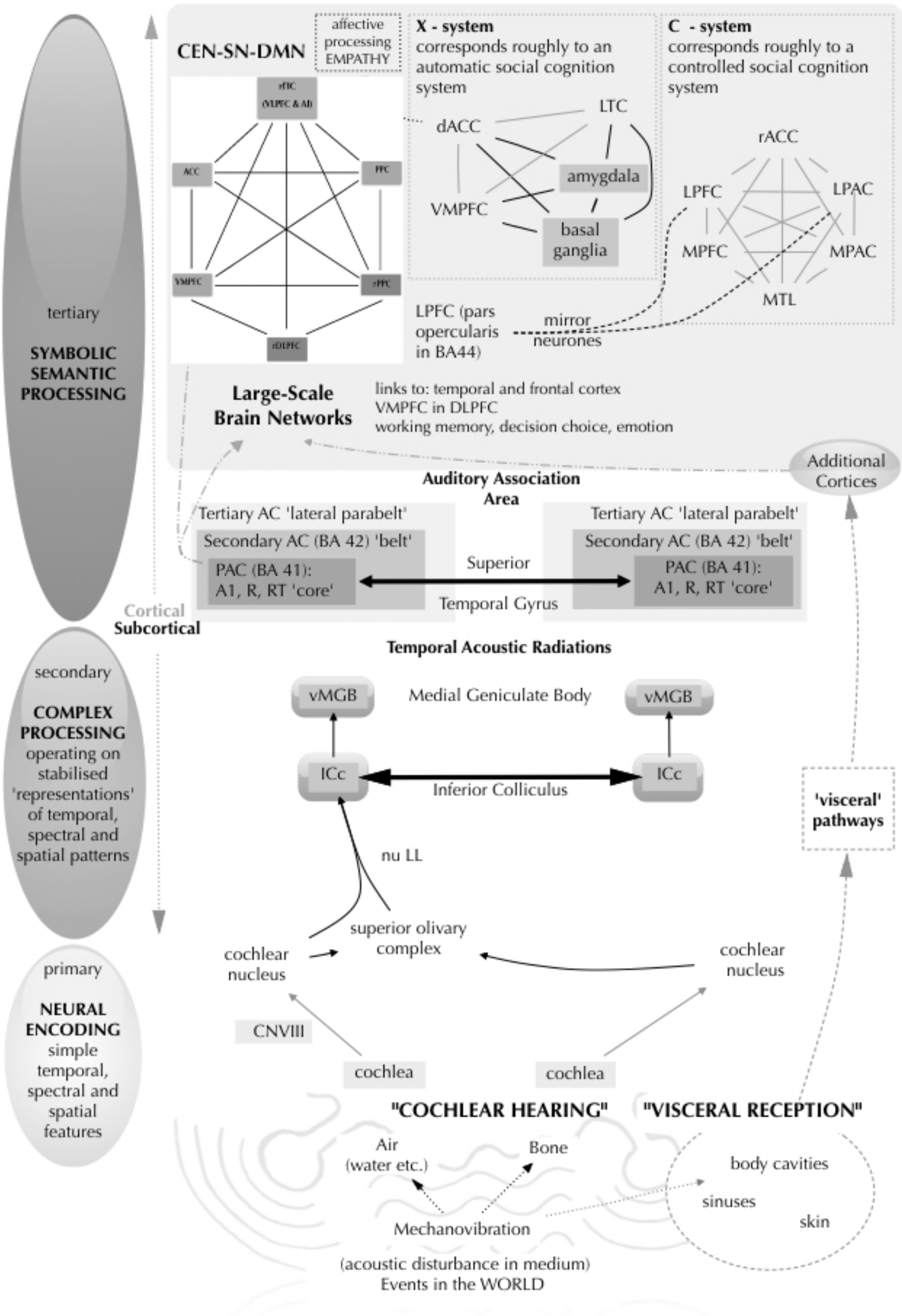

Figure 7: Functional view of the human ascending auditory pathway

The figure shows primary (neural), secondary (complex) and tertiary (semantic) auditory cognitive processing steps (after Griffiths et al., 1999; Griffiths and Warren, 2004; Winkler et al., 2009) and selected large-scale brain networks involved in social cognition (after Satpute and Lieberman, 2006; Lieberman, 2009). Abbreviations are explained in Appendix A2.04.

BOX 1 Sonic-surface

The sensory consequences of actual acts of listening to music; the "energy-sensitive surfaces whose time-varying (and action-relevant) perturbations" (Clark, 2016: xiv-xv) are to be predicted. This includes activation of both 'outward-looking' and 'inward-looking' sensory states brought about by music. The former, exteroceptive sensory channels, includes the reception of acoustic events by **cochleal-trace** at the auditory cortices. The latter, includes proprioception (the sense of the relative positions of bodily parts, and the forces being deployed) and interoception (the sense of the physiological conditions of the body, such as pain, hunger and other visceral states). Interoception includes the **visceral-trace** of sound which crucially contributes to feelings, and musicogenic meanings (see *Appendix 2 A2.02 and Section 3.4*).

The sonic-surface has a temporal envelope, unfolding through time, and predictions concerning these sensory channels is core to the mechanisms for feelings and conscious experiences induced by listening to music (Craig, 2002; Habibi & Damasio, 2014).

The musical sonic-surface carries traces of tooling, or making by human agency. This might be the result of compositional activity as described by Herbert Brün, "Occasionally the composer's activity brings about that which without him and without human interest could not have happened, leaving traces which nothing else could have left" (Brün, 1995: 479). Equally, as a 'covert interaction', these traces might be the result of a listener's attentional strategy (Cross 2010).

BOX 2 Auditory Object (AO)

The basic units of auditive experience. They are (partially) amenable to compositional intervention, and have the following characteristics:

1. **What / where** features bind distinguishable entities that are located within space (see *Figure 6*). 'Objecthood' has four key principles:
   a) **Correspondence** to things in the sensory world;
   b) **Separation** of information related to the object from the rest of the sensory world (i.e. contextual figure-ground differentiation);
   c) **Abstraction** of sensory information that can be generalised between particular sensory experiences in any one sensory domain (equivalent to Husserl's adumbrations). AOs are invariant to spectrotemporal changes which may arise from their perceptual context;
   d) **Generalisation** between senses allows the binding of sensory domains to a single source (such as the face and the voice of the same person, known in EAM as 'source-bonding' (Smalley, 1994));

[continued overleaf]

BOX 2 Auditory Object (AO) [continued]

2. **AOs are categories**. They generalise across multiple dimensions, retaining their designation as belonging to a particular acoustic event. This requires neurocomputational selectivity for object–specific invariant features, simultaneous tolerance for variation in other parameters, and an ability to generalise across features designating membership of a general category of sounds. As categories, AOs can be considered as having exemplar cases and fuzzy boundaries and are conceptual.
3. **Partial introspectability**. AOs equate to things we can say about listening as perceptual object; our ability to verbally access the ST-analysis (the 'sound-in-itself' is considerably more limited);
4. **Mutability and scalability**. AOs are dynamic entities which segregate into objects which may be further perceptually differentiated or aggregated according to ASA/Gestalt principles and attentional focus;
5. **Centripetally & centrifugally** formed:
   a. Centripetal processes operate from the sensory periphery to the ACs and generate an ST-analysis through simple and complex encoding of acoustic patterns which partially determine the AO. This ST analysis encodes components in the frequency and time (FT) domains. FT patterning contains information that is not available in either the time- or frequency- domains alone, and FT boundaries corresponds with perceptible segmentation in listening (de Cheveigné 2006; Tardif et al. 2008; Patterson et al. 1995; Shamma 2001).
   b. Such FT analyses are not identical with AOs. The different meaning of sounds as "fully subjective to the listener" can arise when the same ST patterns elicit different responses in AC dependent upon listeners' judgements (Kilian-Hutten, et al. 2011: 1715). This arises due to the influence of central (post AC) higher processing on the AO. These centrifugal processes typically operate amodally and include innate or learnt cognitive schemata, working memory and attentional processes. This is analogous to the visual domain, where the 'figure' or 'ground' distinction arises as a function of both perceptual (centripetal) grouping and (centrifugal) attentional mechanisms
6. **AOs are predictive.** They are formed by selection between multiple competing proto-objects - 'on-the-fly' potential predictive models.
7. **AOs are motoric** and carry implications for action and response. They have consequences and are future-oriented. This relates to Koelsch's 'action – effect principle' and to 'pre-potent response'. During the neural modelling of AOs, motor impulses are generated, that is sound perception links automatically to possible actions. These impulses are filtered out (by the frontal executive) with only a subset making it to actualisation.
8. **Attentionally salient**. Attention activity can extend centrifugally down into early sensory processing and enable the selection of particular AOs which are of particular interest.

[continued overleaf]

BOX 2 Auditory Object (AO) [continued]

9 **Affective**. AOs are not simply perceptual, but modulated by emotional significance and processes of thalamocortical re-entry linked to their salience.

10 **Tools of consciousness.** AOs are salient objects (or sonic images) which are formed according to their adequacy to the neurocomputational demands for action by a perceiver in an environment.

3.3.2 Apophenic mode

We commonly think of perception as sensing externally real states of affairs. The corollary is that hallucinations are untrue perceptions – that is a phenomenal content despite the absence of an external causal source. However, auditory perceptual activities also spontaneously emerge from the background noise[43] of neural signals in the Default Mode Network[44] (Alderson-Day et al., 2016). Auditory hallucination is the generation of AO imagery which is equivalent to externally attributed source causes[45]. This involuntary perception is usually accompanied by the conviction of it containing a coded meaning intended for the recipient. However, beyond this strict psychiatric sense, in more general terms, this reveals what I call an 'apophenic' mode of listening.

Klaus Conrad (1958) proposed 'apophenia' to describe the spontaneous connection of meaning between unrelated phenomena which marks the perceptual experience of some psychopathological states (Mishara 2010). This "experience of seeing meaningful patterns or connections in random data" (Petchkovsky 2008: 247) emphasises the centrifugal formation of trace relatively untethered to external correspondence, to the ST patterning of auditory coding.

[43] In Part 2, I discuss my *m-Log* controller which has its own intrinsic activity, generating noise that analogically operates in a compositional 'apophenic' mode.

[44] The default mode network (DMN) subserves the mind-wandering social psychological baseline state. It is one of the canonical LSBNs discussed in Section 3.5.

[45] In Chapter 4, Robin Mackay suggests 'hallucinatory' as a mode of auditory perception. For the reasons discussed here I think 'apophenic' mode is both more accurate and more generalizable for sound theory.

Such apophenic processes are inherent in the auditory cortices as the locus for internally generated auditory imagery founded on the mnemonic recall of the trace of auditory experience and the trialling of possible scenarios mentally (Zatorre, 2007). I suggest this apophenic mode is central to the activities of electroacoustic composers: the conviction that we generate a coded relation between perceptual objects and representational systems, a discursive elaboration of trace between percept and concept. The implications will be pursued in Chapter 4.

3.3.3 Mnemonic trace

I develop the notion of trace here, bringing together compositional and cognitive science perspectives. Trace is encoded when events in the world bring about neural microstructural changes that persist over various time scales[46]. A working model of memory is useful to composing temporal flow and the chaining of traces (Xenakis, 1992: 262; Brün, 1995b: 479). I shall briefly discuss two models relevant to non-tonal, non-metric musics: Cue-Abstraction Theory (CAT) and the Working Memory model (WM) in Figure 8 (Baddeley and Hitch, 1974; Deliege, 1996; Baddeley, 2003; Weinberger, 2004; Heathcote et al., 2010).

WM is a convergent scratchpad through which the composer may (or may not) satisfy listening expectations. It combines persistence across differing temporal scales in different processing systems (Crowder, 1993; Jonides and Smith, 1997). Long-term semantic, episodic and language systems reciprocally feed an 'auditory-spatial sketchpad', a 'phonological loop' (in speech production) and 'episodic buffer', that link to the central executive control of thinking and planning associated with frontal cortical circuits. Recruitment of neuronal assemblies across different regions is typical for WM, and appears to be the way in which specialised subsystems are brought into coherence in cognitive tasks (forming large-scale brain networks (LSBNs)), including in music perception.

[46] This internalises memory as something that belongs to the individual. Aspects of experience are also encoded externally as cultural artefacts – the written score, or DAW arrangement are examples – that render knowledge portable, transpersonal and outside of real-time.

In order to apprehend large-scale developments LTM must be involved. Compositional and musicological notions of form operate beyond the confines of WM so some form of schematic reduction must be passed across (i.e. semantic and/or episodic LTM in Figure 9).

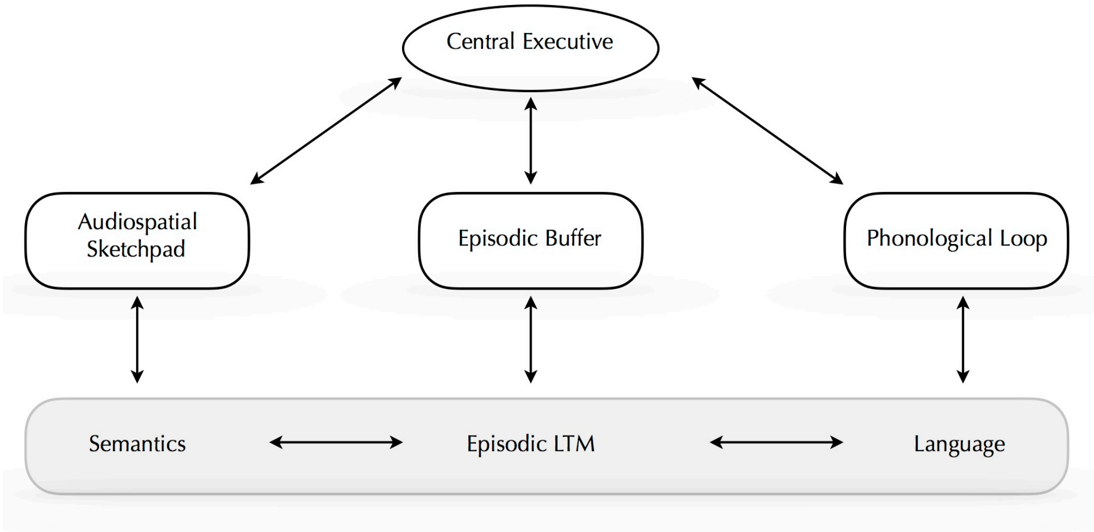

Figure 8: Baddeley's multi-component working memory model (after Baddeley 2000)

Declarative Memory (explicit)	Procedural Memory (implicit)
Episodic memory:	**Procedural memory:**
1. autobiographical events (times, places, associated emotions, and other contextual knowledge);	1. long-term memory of skills and procedures, or "how to" knowledge;
2. may be explicitly stated;	2. not easily verbalised.
3. dynamic and changeable by recall.	
Semantic memory:	**Perceptual memory:**
In music, the basis for forming general expectations about event types, distributions, and structural regularities such as tone, meter and standard forms	Perceptual representation system (also known as perceptual learning)
1. memory of meanings, understandings, and other concept-based knowledge unrelated to specific experiences;	1. unconscious statistical learning (Bayesian, probabilistic);
2. conscious recollection of factual information and general knowledge about the world;	2. encode regularities in the environment;
3. independent of context and personal relevance;	3. structures unconscious expectations about events;
4. a continuum – representing the two extremes – from the particular, through generalisations to abstract knowledge;	4. basis of recognition, and implicated in schema formation.
5. basis of schema formation.	

Figure 9: Summary of long term memory types (after Tulving, 1984; Peretz and Zatorre, 2005; Snyder, 2009)

CAT emphasises that units of memory are created by any distinctive feature in the surface (termed 'cues') that can occur over a variety of time scales, which I take to be equivalent to the 'pertinences' discussed in EAM (Smalley, 1993: 423; Delalande, 1998: 19). Cues are cognitive reference points, markers that anchor memory and create the basis for mnemonic segmentation into chunks. The trace of sonic surface is then differentiated by event hierarchies that relate to one another as dependencies according to conceptual and mnemonic processing (Snyder, 2009). This brief tour of memory yields a number of compositionally useful concepts:

(a) Compositional process (such as DSP interventions or synthesis) operating around 250 ms or less will be integrated into AO formation (consistent with Curtis Roads' microtemporal scale (2004)).

(b) WM affords up to a 4–8 second moving window through which music is apprehended. There is an upper limit of around four 'chunks' that STM will hold, but further items may be nested according to compression hierarchies.

(c) Significant change in sound marks boundaries that register difference in trace. These saliencies may form mnemonic anchors (cognitive reference points), operating over different time spans.

(d) Factors that are salient and articulate segment boundaries at a low level (such as pitch contour, temporal phrase boundary or rhythmic change) are also operative at higher levels marking larger temporal forms.

(e) Higher level segmentation (such as a section boundary) operates over larger time spans, usually through more pronounced changes involving a greater number of musical parameters.

(f) Listeners' schemata are organised around abstract prototypes, such that variations (which are heard as similar) are categorised in terms of generalised representations of thematic material.

The visceral (linked to felt-sensations) and cochleal (perceptible audible) contributions to trace can be elaborated as a function of mnemonic inscription, that is, what sound leaves of audible experience. With respect to the LTM types of Figure 9, trace may be implicit (perceptual or procedural), working or explicit (episodic or semantic). Perceptual trace operates unconsciously forming auditory objects and expectations about the experience of sounding events[47]. Procedural traces are embodied processes by which we form and respond to sounding events. While they are key to our experience of sound, neither are readily verbalisable, although the latter may be communicated as a contagious gesture. As implicit memory functions, these traces are largely transparent to introspection, but I suspect underpin the sonic materialist notion of events as relatively autonomous affects. Like visceral trace they pass largely outside of linguistic capture, but are embodied musicogenic effects on a receiver.

Explicit traces determine what we can say of sound. They are either episodic or semantic, and the dominant meaning of trace as I use it in this writing. Working trace is an intermediary, operating over the future-facing window of 'now', which constitutes the experience of sound. Only sounds saliences, how it inscribes itself in use might be retained as a communicable.

Episodic trace is linked to our listening biographies, to the contexts of times, places, emotions and personal significances. Semantic trace is conceptual understanding of sound (as sign), shared conventions, meanings and discourses, on a continuum from the most particular instances to the most abstract generalisations. While episodic trace is personal, changed by recall and may be highly linked to composer motivations, semantic trace is knowledge independent of context and personal experience. Both may be explicitly recalled, brought into language and territorialized by the authoritative discourses about sound.

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[47] Auditory perceptual memory (AO formation) spans around 250 ms (Sperling, 1960, after Snyder, 2009), of the same order as the re-entrant loop subtending the PMIR-PSM modelling discussed in Section 3.2 (Seth, 2007) and the micro compositional timescale (Roads, 2004).

3.3.4 Syntactic dependencies

> Although formulated here with regards to the processing of tonal music, the logic of this enumeration is supposed to be applicable to other kinds of music as well (Koelsch, 2013: 102).

Musical syntactical processing in the K-matrix is concerned with organising perceptual and mnemonic regularities and schematic structures. It has similarities with grammar in language, but syntax is found in any hierarchically organised complex behaviours such as motoric actions and mathematics (ibid).

Composers and listeners refer to motivic developments, cadences and so forth. While these pitched aspects are generally not to the fore, EAM makes use of such tonal devices[48]. Whether we can strictly speak of syntax based entirely upon non-pitched features such as timbres, loudness or space is an ongoing question (Huron, 2001). In common with many EAM practitioners, I think that we can speculate compositionally, and Koelsch's findings on syntax are of interest. Three kinds of syntax can be differentiated:

(a) Processes that do not require long-term knowledge (i.e. trace encoded beyond moment-to-moment perceptual memory).

(b) Processes based upon long-term knowledge (working and long-term memory systems) and involving the processing of local but not (temporally) long distance dependencies.

(c) Processing hierarchically organised structures that include long-distance dependencies, particularly semantic trace.

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[48] In Denis Smalley's *Sommeil de Rameau (2016)* a recurring 6/4 cadential progression acts as a double appoggiatura that is resolved downwards in the progression from 2nd inversion tonic to root positioned dominant. Despite the pitched material being submerged by surface timbres that have more diffuse pitch centres, and quick iterative pulse-like gestures, the harmonic progression gives a distinct allusion to baroque tonal practices and a strong sense of cadential closure (personal communication with the composers Peiman Khosravi and Alex Hill, 2016). Similarly, in Smalley's *Fabrezan Preludes* we hear Debussian pentatonic allusions with ascending fourths and dominants. A further example is *Shur* by Alireza Mashayekhi which is based on manipulation of pitch glissandos and spectral components derived to the Iranian *dastgah* system (for an analysis see Saboon, 2010).

Not all three of these processes apply to all musics, nor are they necessarily sequential and may partly happen in parallel. They are summarised in Box 3.

BOX 3 Music Syntax

Musical syntax is a fractionable process with steps equivalent to musical perception. For my BPS_paC, I have suggested terms for each of the three kinds of syntax identified:

1. '**perceptual trace**' is pre-attentive, relatively automatic and not under volitional control. It relies on perceptual memory (in the range of milliseconds) which detects low-probability deviations in acoustic signal without requiring knowledge.
2. '**present trace**' compares the content of the working memory buffer (usually around 4-8 seconds) with regularities stored in long-term memory (knowledge), establishing a hierarchy of expectations through stabilised local, moment-to-moment dependencies.
3. '**long-distance trace**' builds on the above, and requires long-term memory and semantic knowledge to establish longer term dependencies between musical elements (i.e. not currently perceptually held in working memory).

3.4 Sign and linguisticity

Returning to Cox, a key reason for his rejection of interiority and Kim-Cohen's 'linguisticity' is given below,

> Musical composition and sound installation are surely historically situated and socially embedded practices that are culturally meaningful. Yet music has always been recognized to be a peculiarly non-representational art, lacking the two-tiered structure of reference characteristic of words and images […] musical tones and works are not signifiers, not media for the expression of a semantic content. They do not, for the most part, symbolize or stand for some other thing. They are not icons, indices, or symbols, to use C.S. Peirce's tripartite division of signs (Cox, 2011: 148).

A BPS approach offers a straightforward refutation of Cox's second point, and discusses the relation between the perceptual and conceptual that Kim-Cohen separates out. In this section I show that music is neurocognitively semantic, sharing overlapping neural architectures with language. It conforms to Peircean semiotics, but extends beyond sign qualities (Patel, 2008; Koelsch, 2013: 156–85).

3.4.1 Music semantics

The semantic domain hinges around intra-musical relations [D4]. To the left it includes conceptual sign interpretations, and to the right non-conceptual embodied musicogenic behavioural responses by listeners. While this might imply the conceptual as an earlier stage, the temporal processing is multiply determined, and emerges from several domains and dimensions in concert. Acoustic signs are conceptual because of activation in Wernicke's area (WA)[49] which is crucially involved in semantic processing (Koelsch, 2013: 166–7). However, WA has analogues serving equivalent functions in animal vocalisations (Christopher et al., 2010). Hence, conceptual meaning is not entirely a discursive function of human linguisticity.

Koelsch differentiates three key processes by which music communicates or evokes meaning for a receiver (see Figure 10, and summary in Box 4).

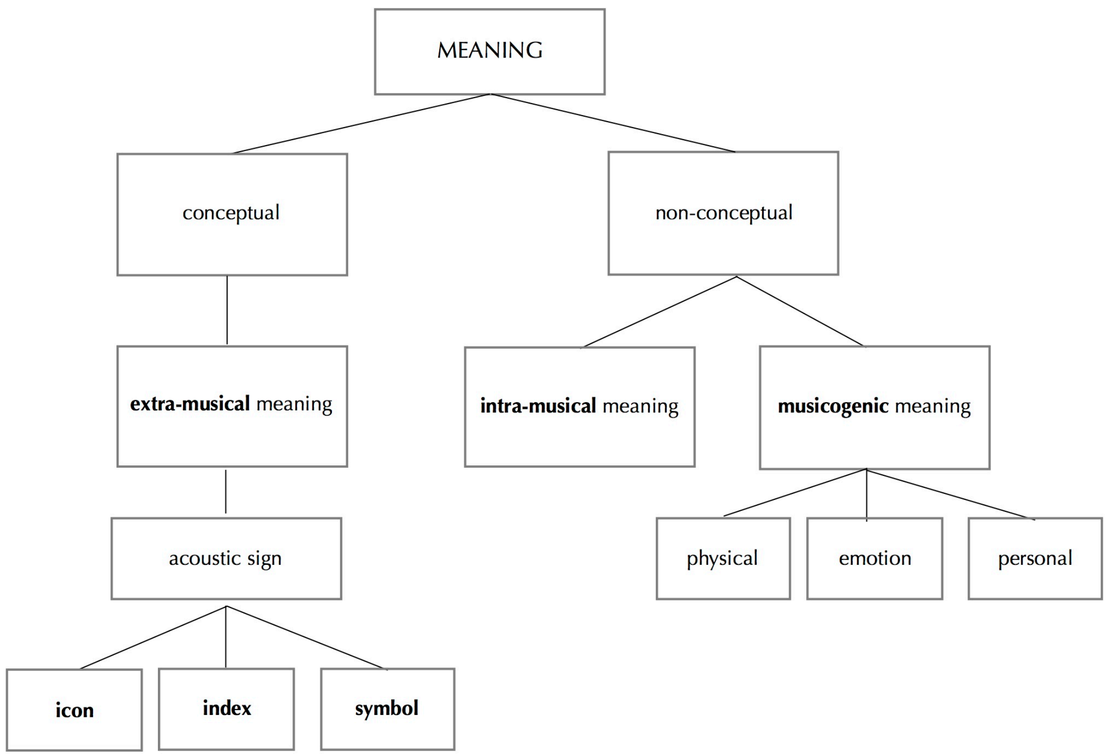

Figure 10: Musical meaning (summarising Koelsch 2013: 156–85)

[49] Wernicke's area lies within the secondary auditory area (Purves *et al.*, 2001).

Iconic musical signs [A3]:

> […] emerge from musical information resembling sounds of objects, qualities of objects or qualities of abstract concepts. Examples […] include the imitation of the sound of an animal's voice… weather-related sounds […] qualities of a fictional being (Koelsch, 2013: 158).

Sound's trace is first an icon signalling the presence of something inherent in the sign itself, bearing a physical resemblance to what they represent (Tagg, 2012). In EAM, field recordings and other referential 'real-world' sounds are iconically themselves. Even a single sine tone has such a quality.

Indexical musical signs [B3] indicate interiority – the psychological state of an individual, such as mood, emotions, intentions and motivations. Indices signal the presence of something that is not inherent in the sign itself[50], but 'connected by spatiotemporal proximity or by causality to what they represent' (Tagg 2012: 17). They are inherently action-related, and fundamental in music. An emotional state of trepidation may be expressed in the vocal apparatus by increased muscular tensions resulting in specific spectral changes, microtonal pitch alterations, acoustic roughness and so on. In biosemiotics, these are referred to as 'affect codes'[51] and it has been suggested they evolutionarily gave rise to tonal movement in music (Cross and Woodruff, 2008; Habibi and Damasio, 2014). Acoustic features expressing basic emotions[52] in music are highly similar to the acoustic properties that code emotional expression in the prosody of language (Juslin and Laukka, 2004).

Symbolic signs [C3] require knowledge of conventional sign meanings and parallel musical expectancy formation [C2]. Meaning emerges from an arbitrary association with an extra-musical referent that might be conventional (e.g. music with specific ritual purpose, or

[50] An index is, 'an utterance or pointing to a state of affairs – like smoke indexes fire' (Sebeok, 1996: 19).

[51] This 'affect code' is explored in my piece *Makharej*, discussed in Chapter 5.

[52] These are anger, fear, happiness, sadness and tenderness and derive from the work of Ekman (1971 and 1999).

national anthems) or idiosyncratic (e.g. associating a particular ringtone with a person). Symbolic meanings can extend to social associations such as subcultural or ethnic groups (Patel, 2008). They are closely tied to cultural practices[53].

BOX 4 Musical Semantics

1. Evidence suggests three ways by which music either communicates meaning, or evokes processes that have meaning for a receiver. They have multi-dimensional determinants, emerging from several domains and dimensions simultaneously.
    1.1. **Extra-musical meaning** emerges from iconic, indexical and symbolic sign qualities which reference a musical sign to an extra-musical referent and is a form of conceptual knowledge. These are AOs as sign and are distinguishable through the N400 and N5 components of event-related brain potentials, and differential activation of WA on functional MRI.
    1.2. **Intra-musical meaning** emerges from structural relations between musical elements, and carries non-conceptual meaning.
    1.3. **Musicogenic meanings** are feeling sensations which come before verbalisation and emerge from the physical activities, emotional and personality-related responses, linked to vitalisation and evoked by music. This is *a priori* musical meaning - where music defines 'a sensation *without this definition being biased by the use of words*' (my italics) (Koelsch 2013: xi).
2. Beyond music specifically, meaning arises from the relationships between perceptual elements as they become established into a predictive structural model and its modifications as the activity proceeds. This is in common with lyric poetry, rhetoric, aesthetics, visual arts, and linguistics.
3. Musical meaning usually lacks the explicit specificity of language, but exhibits 'floating intentionality', where meaning is bound to the contexts in which it is experienced, such that while individual specific meanings may be widely divergent, participants feel that their experiences are in alignment (Cross 2012).

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[53] Such symbolic references are key to my triptych *On the Admissibility of Sound*. It is obvious in *Makharej* with the use of the Arabic letters, but these letters also symbolise cultural norms regarding divine authority. In *The Remainder*, the sound of the daf is symbolically linked to religious practices. In *BGZ*, there are multiple symbols operating e.g. the sounds of birds link in Islamic mythologies to the soul, a gate slamming refers to *ijtihad* 'the closing of the gates of reason' in Islamic theology, the *adhan* again symbolising the presence of religious power.

3.4.2 Model-based knowledge and the reception-interpretation-action triple helix

These finding from the K-matrix suggest a model for composition, which also develops an account of distributed cognition through which sonic art-objects, as Peircean indexes, might be said to 'erupt' and exert force in their vicinity.

Koelsch takes the triple sign as 'unit' of communication, but in Peircean thinking it is part of an abductive[54] inferential process (El-Hani et al., 2006). AOs are exactly such perceptual-inferential processes. Peircean semiotics has been applied to listening in EAM and to electroacoustic musicking, suggesting the triadic sign abductively forming a semiotic helix which iterates through time (Ojala, 2009; Oliveira et al., 2010; Shellard et al., 2010). Building on Ojala, key domains of the K-matrix animate as a Triple Helix where a reception stream, interpretation stream and action stream form intermodulating strands as depicted in Figure 11. Through the RIA-helix predictive, imaginative model-based reasoning (by a composer, or an audience listener) proceeding iteratively, undergoes change and modification by experience[55].

I suggest that in human listener-composer minds, the reception-stream incorporates cochleal and visceral traces; interpretation is a placeholder for a broad notion of 'cognition' operating on trace (incorporating aspects of semantics, syntax, affect and sociality); and, action incorporates the receiver's responses, forming the effect of the sign in the interpreter, which may be overtly motoric enaction, covert impulse or affective state.

[54] Model-based reasoning (described by C.S Peirce as abduction) is a form of logical inference that goes from an observation to a theory that accounts for the observation, ideally seeking to find the simplest and most likely explanation (Magnani, 2009). It is 'inference to the best explanation' (Sober, 2012).

[55] Magnani discusses the origins of this imaginative modelling thus: 'it is better to kill a hypothesis in the mind than to be killed ourselves because we precipitously experienced the real environment' (Magnani, 2009: 364). Thus, abduction is a modelling and imaginal trialling of different possibilities.

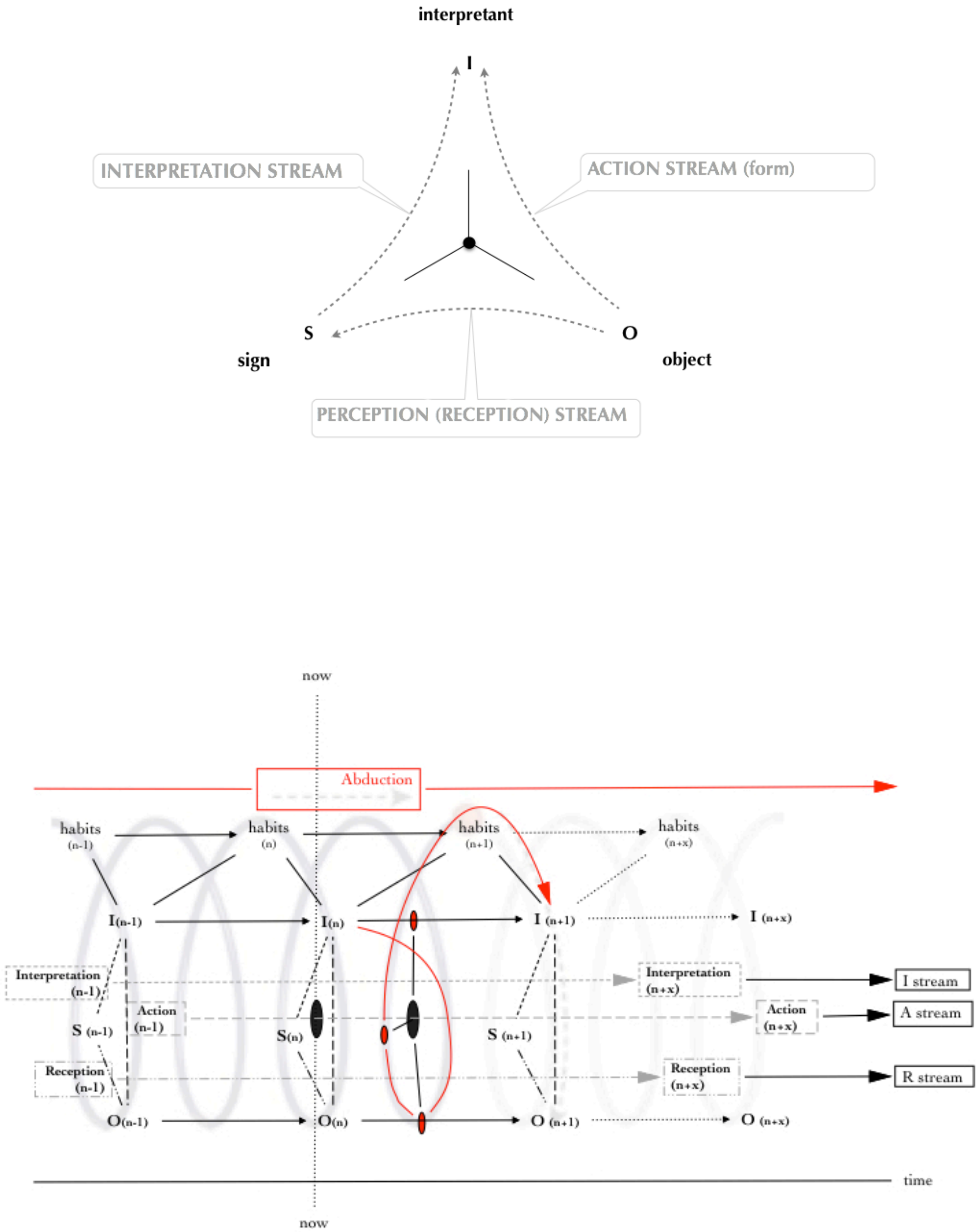

Figure 11: (A) The Peircean triple sign relation. (B) The reception–interpretation–action (RIA) triple helix (adapted from El-Hani et al., 2006; Ojala, 2009: 300)

While Peircean semiotics gives weight to thought-signs and cognising subjects, it also opens the business of interpretation out to non-human and non-organic cognition (El-Hani et al., 2006). Magnani demonstrates that abduction underpins distributed cognition, the interplay of internal and external trace, by which 'humans extend their minds into the material world, exploiting various external resource'[56] (Magnani, 2009). In Metzingerian terms, this models a triadic pulsation of reception, interpretation and action in the causal interaction space of the real material spatiotemporal world.

The RIA-helix allows the K-matrix to contact developments in social sciences, particularly actor-network theory (ANT), developed in musicology as networked mediations (Born, 1995; Hennion, 2003; Born, 2005; Latour, 2005; Law, 2011), and the various applications of distributed cognition, enactive embodiment and ecological psychology in music (for examples see Clarke, 2005; Armstrong, 2007; Green, 2011). In Gell's anthropology, art is sociality extended through distributed agency, where art objects are cognitive Peircean signs that index activity within their vicinity (Gell, 1998). Art emerges from the social relations of objects mediating social agency, 'the network of relationships surrounding particular artworks in specific interactive settings' (ibid: 8). In their theoretical construction, art objects and persons are equivalent; both are social agents.

I am arguing that music (and sound art) operates as such a cognitive object, an agentive interlocutor, as a social other within a network of objects. Human perceivers are nodes within networked interactions of actants and distributed cognition. Or, more exactly, the perceiver, as a punctualized[57] biopsychosocial network opens out into a network of cognitive

[56] '[…] a cognitive niche emerges from a network of continuous interplays between individuals and the environment, in which people alter and modify the environment by mimetically externalizing fleeting thoughts, private ideas, etc., into external supports. Cognitive niche[s] […] contribute to making available a great portion of knowledge that would otherwise remain unexpressed or unreachable' (Magnani, 2009: 317).

[57] Society, organisations, agents and machines are the effects that are generated in these patterned networks of diverse materials operating together. However, these networks can consolidate and come to look like 'punctualized' or 'single point actors' (Cressman, 2009). The common ANT analogy is the technological black box that exerts its power, and has its capacities and limitations with which we can interact without ever knowing what exactly it contains. This is also a basic premise on object-oriented programming.

objects embedded within ecologies or assemblages of technologies and wider social actors. I will return to these assemblages in Chapter 4.

3.5 Interiority and exteriority: mentalizing and listening stances

We have rapidly toured a number of terrains. Before drawing these together, I consider some recent findings in social cognitive neuroscience that address the nature of the interiority–exteriority distinction debated in Chapter 2, and the proliferating phenomenologies of listening that I noted in my opening comments.

Kim-Cohen, like Sterne, referred to interiority as music thought primarily as immersive and affective, contrasting with the exteriority of vision identified with thinking and understanding. For Kim-Cohen, linguisticity, as the order of things, confines techne. For Cox, the primacy of experience (as a linguistic and humanistic interiority), was set against the autonomous exteriority of evental flows, giving credence to the noumenal power of the sonic. In this section I find agreement and disagreement with both views, and argue that the distinction arises as a fundamental condition of human cognition deriving from dual-process social cognition systems subserved by large-scale brain networks (LSBNs). Sounds index intentions automatically by engaging social cognition [B6] and theory of mind (TOM) networks[58] (Steinbeis and Koelsch 2008). Listeners mentalize sound's trace, attributing mental states and discerning intentions.

LSBNs are large-scale neurodynamic coherences, distributed neural arrays that couple and come into co-ordinated activity during cognition and which variably underpin auditive experience and the social brain (Levitin, 2006; Lieberman, 2007; Sridharan et al., 2007; Bressler and Menon, 2010). Bound by WM, they come in and out of correlation /anti-correlation and are key to the listener-composer PSM modelling across various task-focused and resting, default mode states.

[58] 'Mental state attribution', 'mentalization' or 'adopting an intentional stance' are used interchangeably in the literature, and are neurally instantiated in the TOM networks.

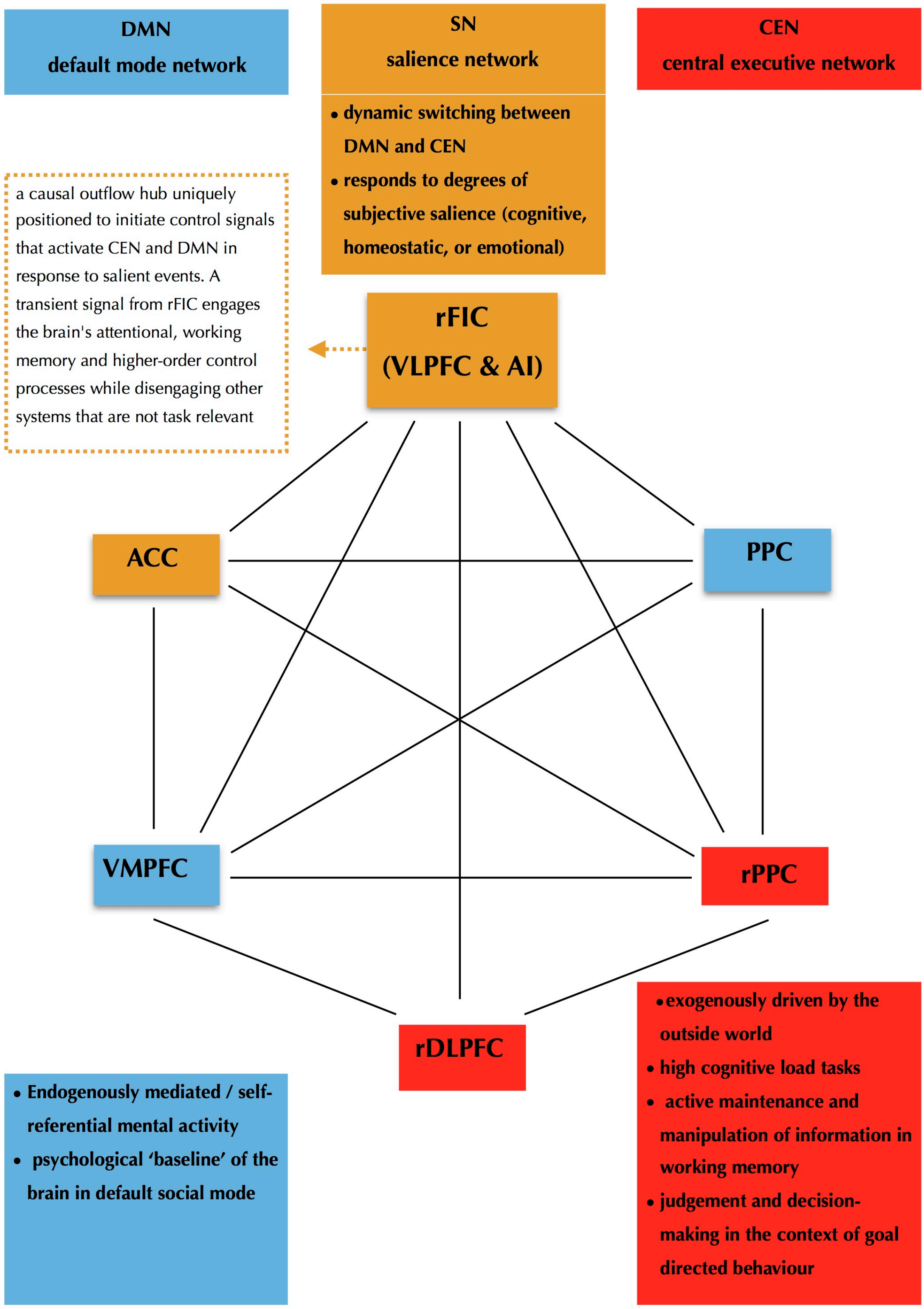

Figure 12: Three canonical networks of the social brain (developed from Satpute and Lieberman, 2006) (abbreviations are discussed in Appendix A2:05)

Abbreviations: ACC AI anterior insula, ACC anterior cingulate cortex, CEN central executive network, DMN default mode network, PPC posterior cingulate cortex, rDLPFC right dorsolateral prefrontal cortex, rFIC right fronto-insular cortex, rPPC right posterior parietal cortex, SN salience network, VLPFC ventrolateral prefrontal cortex, VMPFC ventromedial prefrontal cortex.

Whichever of the authoritative territories we invoke, whether authentic perceptual features, cohering trace-images or equanimity with regard to sounding events, attention is fundamental. Attentional focus typifies the centrifugal and is generated through the activities of three canonical LSBNs (shown in Figure 12, and at the top of Figure 7).

The default mode network (DMN) (already mentioned in relation to apophenia) subserves sociality as the psychological baseline of consciousness[59]. It forms part a reflexive X-system (Lieberman, 2007). The salience network (SN) subserves a gating function directing activity towards significant events (of whatever kind, internal or external), recruiting the cognitive resources of the central executive network (CEN) to the task in hand. The CEN forms the controlled, explicit, reflective C-system (below), and was key to Baddeley's WM discussed in Section 3.3.3.

3.5.1 Mentalization and listening stances

Thinking with Gell, Magnani and others, art-objects operate as Peircean signs to index states of affairs. Extending this idea, music is equivalent to persons as socially agentive others, and this is identified in the K-matrix as mentalization, operating through TOM networks. Mentalization is the capacity to understand the mental states of oneself and others, and to hold these states as underlying overt behaviours (i.e. of being causative). This relies on coherences across LSBNs that I shall discuss shortly.

Mentalization deals with what I shall call 'interiorities', with the fact that our mind is aimed at, is about something (what Metzinger described as ownership of a first-person perspective). It puts us in an imaginative realm that is between external reality and fantasy; into what Ogden (1985) terms 'potential space': a frame of mind in which playing might take place. Mind is decoupled from reality, while remaining anchored to it (Leslie, 1987). As we

[59] These are functional brain states associated with mentation that includes processes such as mind wandering, autobiographical memory, reprocessing of memories, introspection (i.e. self-referential thoughts), envisioning the future, and understanding the perspective of others (Wilkins, *et al*., 2014; Simon and Engström, 2015).

are biologically predisposed to mentalize through what Bogdan (2003) refers to as an 'interpersonal interpretive stance', I shall outline a preliminary account of 'listening stances'.

Two dual-process cognitive LSBNs operate in tandem, reciprocally, and interpersonally. Hence, in Figure 14C they are shown as double-helices, more like DNA than on a simple continuum (Satpute and Lieberman, 2006; Lieberman, 2007; Bateman and Fonagy 2016). They are reflexive/reflective core processes (X and C systems), and internally/externally-focused social cognition (I and E systems). Our capacities to mentalize (to have an idea of our minds' 'aboutness') and for our mind–brains to synchronise and exchange arise from these systems (Fonagy et al., 2002; Gallese, 2003). I suggest that they constitute the basis for dimensional spaces of what I think of as the 'sonic-social' – that mentalizing music is fundamentally linked to social cognition, as shown in the K-matrix. I suggest that the many EAM taxonomies of listening might be located within such a mentalization model[60]. I do not propose to explicitly map the many listenings modes extant in the EAM literature, and will leave that for future work. My intention here is to suggest the potential utility of the approach and to outline an initial model.

Some of the X-C system's characteristic (in Figure 13) will be familiar from the interiority–exteriority debate in Chapter 2. The X-system reflexively, automatically, implicitly and affectively senses and responds to the social (including musical) world. The C-system subserves reflective, linguistic, controlled, explicit and conscious appraisal of that world. I think that the former is consistent with Kim-Cohen/Sterne's immersive and affective 'interiority'; the latter, with their 'exteriority' as connected to thinking.

The I-E system is based upon:

[60] An analogy is found in music emotion research where Ekman's discrete basic emotions are now located as positions within dimensional models of valence and arousal (see Juslin and Västfjäll, 2008; Peretz, 2011; and Brattico and Pearce, 2013).

[…] a clear division between the neural correlates of tasks that focus attention on interior psychological worlds and tasks that focus attention on the exterior social world and the physical social agents in it (Lieberman, 2007: 276).

X-System	C-System
Parallel processing	Serial processing
Fast operating	Slow operating
Slow learning	Fast learning
Nonreflective consciousness	Reflective consciousness
Sensitive to subliminal presentations	Insensitive to subliminal presentations
Spontaneous processes	Intentional processes
Prepotent responses (impulse)	Regulation of prepotent responses
Typically sensory	Typically linguistic
Outputs experienced as reality	Outputs experienced as self-generated
Relation to behaviour unaffected by cognitive load	Relation to behaviour altered by cognitive load
Facilitated by high arousal	Impaired by high arousal
Phylogenetically older	Phylogenetically newer
Representation of symmetric relations	Representation of asymmetric relations
Representation of common cases	Representation of special cases (e.g. exceptions)
	Representation of abstract concepts (e.g. negation, time)

Figure 13: Features of the X- and C-systems posited to support reflexive (analogous to automatic) and reflective (analogous to controlled) processes (adapted from Satpute and Lieberman (2006) and Lieberman (2007)

I suggest this maps onto the interiority–exteriority distinction made by Cox – between significative systems and evental flows. This I-E system, however, reveals counter intuitive findings and '[…] is not a distinction between self- and other-focused cognition' (ibid: 261).

The E-system is activated by tasks that focus attention on the external, observable physical characteristics of oneself, others and the interaction of the two. These are largely non-mentalizing TOM tasks such as appraising physical events, and mimetic action-observations. The focus is on exteroceptively perceived features and actions that are experienced as part of the material world. Engaged through the E-system, this is an exteriority in Cox's sense, a cognizing of sonic art-objects as evental and material.

The I-system is activated by tasks that:

> […] focus attention on the internal, mental, emotional, and experiential characteristics of other individuals or oneself' (Lieberman, 2007: 279).

It instantiates TOM tasks involved with mentalizing, that is, with mental processes generated by one's own *and also* by others' mental states. Like the AO as indexical sign, this interiority includes intentions, dispositional attributions, empathy[61], self-reflection on current experiences, goals, motivations and so forth. Engaged through the I-system, this is an interiority in Cox's sense, a cognizing of sonic art-objects through linguisticity, motivations, systems of meaning, attributing intentions and so on.

The counter intuitive part is that this I-E distinction is 'orthogonal to and cuts across self and other processing' (ibid). That is, it does not map onto the correlationalist self-other divide:

> […] [it] has no clear theoretical precursor in social psychology, but emerges unmistakably from social cognitive neuroscience (Lieberman, 2007: 279).

The implications are intriguing, I suspect far-reaching, and will take some working through. Beyond the action-perception linkage at the level of the individual discussed in Section 3.3, sensorimotor linkage – the mimetic transmission in the E-system – generalises to others. This is supported by findings grouped under the so-called 'mirror neuron systems' that form part of these XCIE systems, known as the neural-social interpersonal manifold (Gallese et al., 1996; Kohler et al., 2002; Ferrari et al., 2003; Gallese and Metzinger, 2003).

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[61] Empathy is primarily internally-focused, and not necessarily explicit and conscious. 'Unlike theory of mind processes that logically proceed from externally-focused processing of situational information and observed behaviours to internally-focused processing of another's mental state, empathy is focused primarily on the experience of another and is thus internally-focused […] in comparison with representing other minds, the sense of experiencing other minds appears to recruit brain regions more closely tied with automatic affective processes …' (Lieberman, 2007: 265).

The perception of other's gestures, and their production by an observer are entangled, linked through mirror-empathy at both the neural and social levels.

> Self and other relate to each other, because they both represent opposite extensions of the same correlative and reversible we-centric space. The observer and the observed are part of a dynamic system governed by reversible rules (Gallese, 2003: 525).

I suggest that this empathic 'we-centricity' is the basis of the 'geometric vectorial relations' of Chapter 2, between self and other models, affording a 'becoming with the sounding' through a geometric relation between subject and object. It turns around affective mimesis and implicit, automatic, symmetric geometries through the neural-social manifold that provides a material basis that links object and subject. Like Lachenmann's structure-sound and Mazzola's presemiotic gesture, we-centricity highlights relatively automatic affectively tuned sounding event, as a co-constructive operation; musicking gestural action forms its listening and listening its construction of event via a reciprocal geometry through this intersubjective manifold.

When the X-system and I-systems predominate, there is a geometric symmetry within the manifold sensitive to gesture, '… a complex reciprocal nonverbal "dance" that occurs between interaction partners …' (Lieberman, 2007: 271). As I suggested after Mazzola in Chapter 2, gesture begins with shared vectorial constructions (based in interoceptively felt-sensations), rather than communicable traces captured and known primarily by language. They are mirror-neuronal resonances promoting transmission of implicit trace between perceiver and perceived (Ramachandran, 2008). Gestures may become syntactically organised, and combine into semiotic, linguistic signs (Koelsch, 2005). Once something salient (perhaps unexpected) occurs, the SN gates open the CEN, recruiting cognitive resources, and the C-system reflectively generates more asymmetric reflective and linguistically tied processes.

Figure 14 shows these processes in the dyad between two BPS listener-musicants, diagramming what I shall call systems of 'interiority' and 'exteriority'. More speculatively, however, if we accept a functional equivalence between persons and sonic-art objects, Figure 14B can be considered as a mentalizing, imaginative 'as if' relation between a listener-

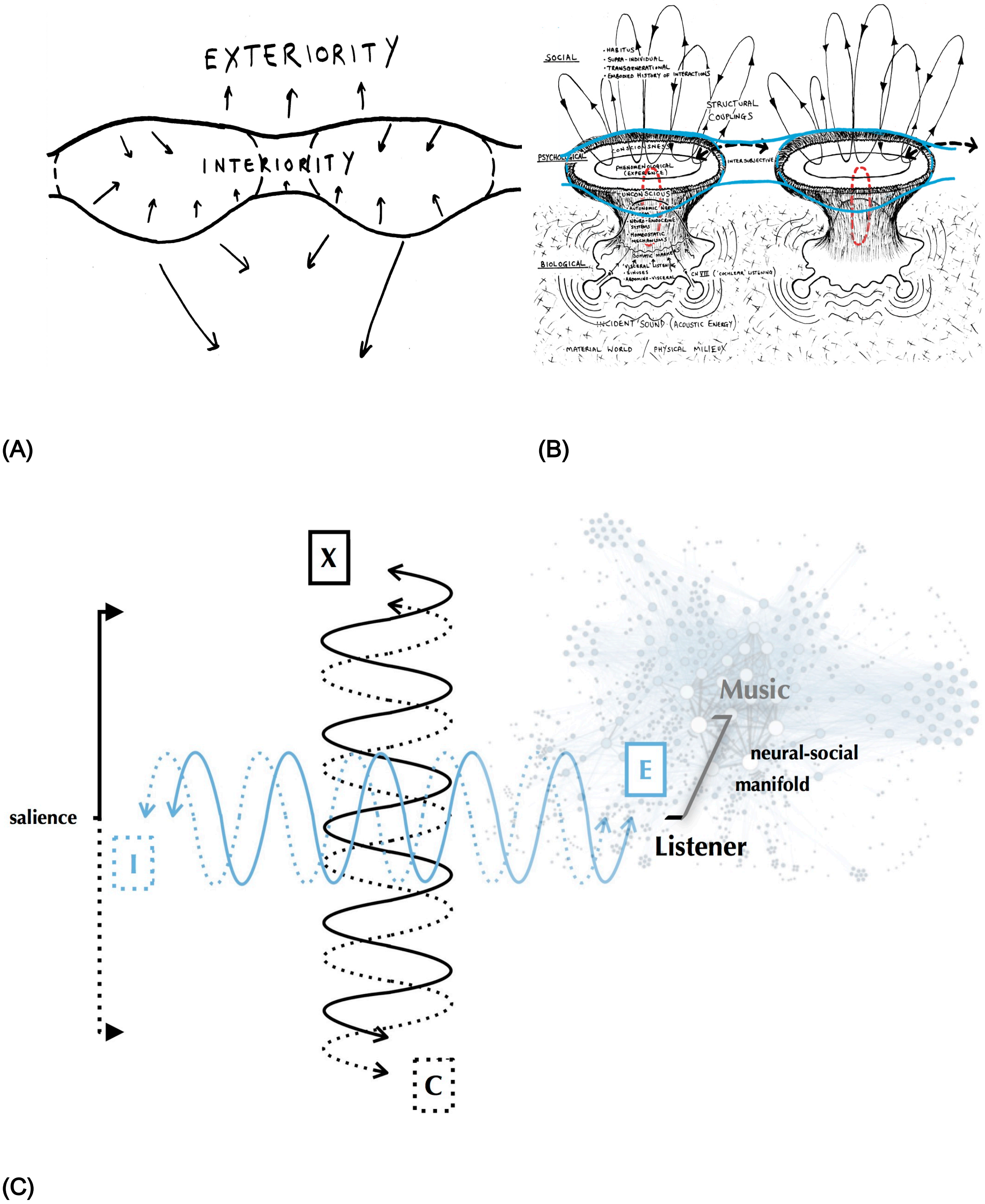

Figure 14: Three views outlining the basic XCIE stances of musical mentalization through the we-centricity of the interpersonal neural-social manifold

(A) shows the shared interiority-exteriority distinction, which is mapped in (B) to the initial BPS model of the individual listener (presented in Figure 5) emphasising interpersonal social cognition between listener-musicants. In (C), sonic saliences (through the SN) gate the recruitment of CEN, phenomenologically switching attentional focus from X-stance (automatic, implicit processing) to C-stance (controlled, explicit processing). The double-helix shows that these stances operate in parallel. Orthogonal to this X-C dimension is the I-E dimension between internally and externally focused mentalization. Additional mentalizing dimensions such as cognitive-affect, and self-other are not shown. Music is schematised in the background image as a biopsychosocial network (see discussion of Figure 15 in Chapter 4)

composer and a sonic assemblage, a punctualized network of heterogeneous cognitive objects composed to form a cohering sounding work[62].

Figure 14A indicates the linked system of interiorities, and exteriorities. There is no self-other distinction per se. The middle image (B) indicates dynamic linking between two social agents (such as two listeners, or comusicants, or even a listener and a sonic art-object). The lower image (C) shows these systems coupled through the we-centric manifold with music, which is shown as comprised of a BPS network (this will be discussed further in the next Chapter, section 4.4 and Figure 15).

The space bounded within the blue lines of 14A represents the shared meta-representational mentalizing space of interiority (Frith and Frith, 2007). The space outside represents exteriority. These distinctions are shared across individuals, not predicated primarily on a self-other divide, but rather linked as mutual interiority and exteriority. If we were to consider, for example vertices in musical group, then a network of linked manifolds would be formed (the basis of Bion's matrix in Figure 1).

❊

A 'listening stances' implies an orientation towards something constructed through systems of interiority and exteriority, and reflexive (implicit) and reflective (explicit) capacities that variably mentalize sound's traces (Figure 14C). When introspecting into auditive experience, listening is found to be aware, intentional, effortful and interruptible. It is a controlled reflective process. Hearing lacks these attributes being largely implicit, providing an online scanning of the streaming events of the world. The salience of events is

[62] This will be discussed as 'sonic assemblage' in Chapter 4.

registered, switching from default mode to central executive cognitive processing, focusing and maintaining attention. Salience gates the recruitment of auditory focus according to shifting and contextually set cues geared towards the anomalous.

This is marked phenomenologically by switching from hearing into listening. I assume that a particular listening will then shift dynamically between stances.

Interiority focuses on intentions and mental states. By mentalizing an interiority explicitly and reflectively (C-I) we find conceptual meaning in behaviours and generate narratives. It tends towards the discursive, to attributions of meanings, motivations, desires, and asymmetrical reflective relations that are symbolically mediated. Linguistic description explicitly attributes mental states. For example: 'there is a scurrying, cautious creature darting about, coming close and then scuttling away'. This I-stance would include much electroacoustic analysis such as reasoning about the signification of sign units organised into larger behaviour networks (Smalley, 1997) or motivated actants and figurativisation (Delalande, 1998: 51).

Our imaginativeness, like our language, is rooted in body-related schemata (Lakoff & Johnson 1999). Mentalizing is not limited to language, and may be implicitly embodied. I may suddenly lean forward as I anticipate a climactic moment in a piece, through a reflexive interiority (X-I). Note the linkage here with the interoceptively based musicogenic meaning in the K-matrix. Mentalizing is often implicit. We do not simply listen, we automatically listen to something as. We do not usually just register the event of a loud voice in close proximity (X-E stance); rather we implicitly mentalize the voice as berating us, the person that raises their voice is angry. This would be X-I, a reflexive interiority, an indexical sign in the K-matrix.

Exteriority is focused on exteroceptively sensed features of trace. When applied reflectively (C-E) I suggest that this would yield a stance characteristic of some technical, analytic electroacoustic listening. For example: 'a succession of rapidly pulsed glissandi, with variable brightness, and fluctuating formant structure'. It is impersonal, and focused on the exterior details of evental flows, rather than being animated by interiority-like attributions of intentions.

I suggest that reflexive exteriority (X-E) implicitly gives itself over to the immersive and affective effects of evental flows. The stance is largely non-conceptual, musicogenic, affectively embodied. It resonates in symmetrical vectorial relation between subject models and evental flows. It does not attribute mental states and the like. I suspect it may be associated with a state of flow (Csíkszentmihályi, 1990) – there is an introspected sense of time being suspended; of losing one's phenomenal self-model in a process of fused reception-interpretation-action, of being exogenously driven by the unfolding sound and where attending to the external 'real' sound is blurred with unconscious processes of implicit mentalization.

❊

In this section I hope to have demonstrated that the interiority-exteriority distinction debated in Chapter 2, arises from the functional structuring of our nervous systems in a socially eventful world. I suggested that this provides a dimensional model for specific dynamic listening stances which mentalize our relation to socially agentive sound as music.

3.6 A biopsychosocial approach to post-acousmatic composition, Part 1

This chapter has rapidly traversed terrains in order to address the philosophical–compositional debates of Chapter 2 on the nature of listening subject–sounding object relations, perception and concept, meaning and linguisticity, and the interiority–exteriority distinction.

I introduced the BPS paradigm and developed some foundational concepts: an eliminativist listening without a listener; opacity/transparency to introspection; the sonic-surface; centrifugal and centripetal construction of AOs; sound's trace as visceral felt-sensation and as cochleally perceived AOs (which link to what we can say about sound);

trace's perceptual, procedural, episodic and semantic inscriptions; apophenic mode; the characterisation of acoustic signs and the linkage with linguisticity and embodied musicogenic meaning; and, mentalizing listening stances arising from dual-process social cognitive systems. I have left the implications of my findings for a BPS_paC largely implicit. I now want to draw out some summary principles and tools to inform composition.

❊

The eliminativist position offers a number of conclusions with respect to the listening and composing debates of Chapter 2. Firstly, there is no listener that is transcendent to the sounding world. Schaefferian phenomenal reductions give no access to data of experience that can be separated from introspection. Both the listener-composer and the sounding world are self-modelling neurodynamic states of a biosystem, sustained within the re-entrant loop of consciousness, and teleofunctionally contextualised in a material world with respect to action, goals and consequences. Introspection into audition is on a continuum between cognitive transparency and opacity – the degree to which we may become aware of ourselves as being in a state of representing.

Secondly, composition is a modelling that structures the causal interaction space of contingent material events in a way that may (or may not) be adequate to the demands of neurocomputational dynamics. The composing PSM might adopt strategies that draw auditory attention to phenomenally more opaque experiences as a special kind of darkness which recruits cognitive resource to the saliences of sound's traces. It may be engaged with not-knowing, and with the acousmatic recuperated as an epistemic tool, and thus pose questions and issues at stake in the construction of a composition. I suggest this is the basis of Demos's 'desubjectivization', Mackay's 'de/naturalisation of the ear', Lachenmann's 'broken magic', and Brün's'anticommunication' that were discussed in Chapter 2. The eliminativist position affords an initial working model of post-acousmatic compositional practice as follows:

Model: composition is the modelling of causal interaction that may be more or less adequate to the demands of auditively focused neurocomputational dynamics, and which has the provocation of cognitively opaque introspective mental processing as a central goal.

To conjoin this with Di Scipio, composition becomes a practice of exploring the causal interaction space of a world and a listening mind by electroacoustic means, which might be unencumbered by 'authentic', 'musical' experience, to access a real beyond the grasp of cognition, but one which nonetheless shapes that cognition. This is then to compositionally investigate the limits of, and to disassemble, the listening subject - object relation, and to imaginatively remodel a world and a listener which could be otherwise.

⁂

In Section 3.3 I demonstrated that we never have access in experience to the material-acoustic real of sound, only the traces that it leaves. While sound's trace may also persist in material artefacts (e.g. recording devices) these are not activated as trace until apprehended as sensation. Trace is formed primarily as AOs, as what we can communicate about sound in audibility, but is contributed to by the visceral effects of sound. While trace has perceptual and procedural aspects fundamental to the experience of sound, this is largely resistant to linguistic communication. Mnemonically explicit trace (either episodic or semantic) primarily determines what we can say of sound.

The AO is a semantic token in a single perceptual-inferential hierarchy. It is an on-the-fly modelling that is linked to futurity, to prediction, rather than to essence (although sparse perceptual invariants, transparent to introspection critically capture the gist of a perception).

Intervention into and remodelling of AOs and their organisation can be guided by the points summarised in Box 2. It suggests a reverse engineering (through the we-centric manifold) that is central to the imaginative teleofunctionalism of the electroacoustic composer PSM. Intervention into known AOs (such as DSP transformations of recognisable sound sources) and the synthesis of novel AOs carries implications for what an object might appear to be, and where (and in what space) it appears to be. AOs as category exemplars shade away through fuzzy edges into other objects, garnering (or confounding) different meanings and establishing the appearance of different sonic worlds, consistent in EAM with spectromorphological and Cue Abstraction Theory approaches (Rosch, 1975; Varela et al., 1991; Deliege, 1996; Smalley, 1997). Cochleal trace (AOs) connect with our linguisticity, to discourse on sound, and are potentially amenable to semiotic development. Smalley's 'space-form' favours such semiotic behavioural networks of objects, where space (the AO's 'where') is structural to composition (Smalley, 2007).

We can imagine a play with the ST plane which is registered tonotopically across the ACs, exploiting or confounding figure-ground differentiation that manipulates background texture and foreground object categorisation, or even attempt to dissolve discrete objects entirely by focus on evolving textures, such as drone based approaches[63].

The composition of novel AOs implies correspondence to things in the sensory world that are not-known. This is then composition as phantasmogenesis, a playing with the appearance of reality, an imagining of worlds that could be otherwise.

Points 3 and 5 of Box 2 (partial introspectability, and centrifugal/petal processes) speak to key themes in Chapter 2 with respect to correlationism. We have no experiential access to the material sounds-themselves although we are able to access this real through technoscientific means. It can be imaged with digital signal tools such as cochleagrams, frequency-time analysis software, or potentially through neuroimaging[64]. The AO arises as a 'synthetic act of consciousness', but this is not a Schaefferian affirmation of a correlative gap between subject and object. The listening PSM is equally such a synthetic act.

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[63] However, this move from auditory object to auditory stream is only apparent, and as a such streams themselves form AOs — captured by point 4: mutability and scaleability.

[64] Eduardo Miranda has made a number of suggestions for the development of tools for the analysis of electroacoustic music based on neurophysiological models of the human auditory system. The suggestion of a hypothetical 'auditory corticogram' which images the auditory ACs is particularly intriguing (Miranda 2007).

The AO is always contextually formed, arising as a salient differentiation of the spectrotemporal topology. It is close to Xenakis', 'notion of separation, of bypassing, of difference, of discontinuity … necessary to be able to distinguish entities, which would then make it possible to 'go' from one to the other" (1992: 262). The way that we might compositionally effect such transits can be usefully informed by the quantitative limitations of different memory systems.

⁂

The extant acousmatic – as listening without seeing – is a convention, now so normative, that we barely notice it; sounds appear as aesthetic illusions, transparently modelling a potential 'real' space despite the absence of a visible source-cause. 'Apophenic' mode suggests a post-acousmatic practice as a voluntary phantasmogenesis, shifting away from any representational obligations towards the real, or limiting praxis to normative aesthetic regimens – the semiotic 'sensorily or culturally accustomed range' as a frame that constitutes 'the extreme outer bounds for the conceptual spaces of each feature' (Ojala, 2009: 419). The centrifugal processes that generate apophenic mode, potentially decouple any obligation between the perceptual and the significative, between trace and representation of external reality. While in pathological or mystical states such processes may be misattributed to external causation, in the voluntarist mode of 'as-if', we might imaginatively unshackle phenomenal content, compositionally reengineering auditive experience.

⁂

The K-matrix neurocognitively disassembles the listening-composing mind and gives a comprehensive framework for thinking sound, which I have left under explored here. Trace functions in conceptual terms as icons, indices and symbols linked to, but not confined to language. It also functions as non-conceptual musicogenic felt-sensations gesturally enacting along with sound, but we struggle to communicate this linguistically.

The RIA-helix can be thought of as a perceptual-inferential motor in the ego tunnel which offers a simplified K-matrix useful to compositional imagination and techne. Both improvisation and studio-based composition operate through the triple intermediations of reception, interpretation and action response streams that flow together in constant intertwining. The helix is powered by model-based reasoning, iterating through and constructing the ego tunnel in composition and musicking, its rate and direction of spin mapping to a concept of time.

Peircean semiosis also provides a basis to access agentive cognitive objects and non-human cognition. If we consider the ways in which objects (such as those in object-oriented programming e.g. Max/MSP, Supercollider, or drums, or curatorial invitations) might be subject to the helix – the ways in which its capacities and constraints yield receptive, interpretive and response characteristics – we begin to glimpse the way in which composition might assemble disparate elements into networks that generate sonic surfaces.

In live improvisation, the helix spins largely unidirectionally through real-time; whereas in the studio it can be reversed and fast-forwarded, paused, and re-spun as different possibilities, different RIA models can be scrutinised, reworked and reconsidered. Electroacoustic music (whether live, fixed or installation) encourages model-based abductive reasoning in particular, through an emphasis on the sonic-not-known. Each piece might generate its own coherences (with respect to the domains of the K-matrix) and tends towards less reliance on genre norms[65] – which would encourage a deductive inferential reasoning.

❊

I regard the K-matrix, RIA-helix and listening stances as complementary ways in which to think composition and improvisation as a continuum. Studio-based composition is largely a non-real time and primarily reflective activity, with the objective (in semantic/semiotic terms) of constructing the sonic as both conceptual sign and as evental force. The AO, as sign, could be a written score, but I primarily consider it electroacoustically as the physical

[65] Although, as I objected in Chapter 1, there has been a tendency towards rather generic EAM.

acoustic signal and its received sonic surface. A digital sound file can be considered as isomorphic with the acoustic signal under good reproduction circumstances. The role of the electroacoustic composer is to produce a finalised object by organising the contingencies between material events that register at the sonic surface, becoming mentalizable as an interiority and/or as an exterior agentive force that might capture listening, and thus exert effects in its vicinity. In studio composition, there is usually a generate-and-test cycling of the RIA-helix. Actions are taken, the resulting effects upon the sonic surface received and interpretations undertaken, which generate iterating modelling.

The listening stances can add detail to the streaming helix. Perceptual features that are (for any number of reasons) salient at a particular moment, are interpreted according to dynamic movement between X, C, I and E poles. The composer's reception may primarily lie along the reflective axis, shifting attentional focus between exteriority (e.g. spectral balance or articulation of the spatial image) and interiority (vectorial perspectives such as how the sound is behaving; what it is intending or what motivational states are being indexed).

In improvisation (such as in groups) the same stances and helical processes are operative but with a difference of dynamic stance positions. Mutual reflexivity may be to the fore, but can dynamically shift and be reflected upon, and actions modified (tweaking supercollider patches, or focusing more on exteriority to better articulate an interiority). The two musicants' stances are likely to shift in and out of coupled synchrony proliferating the musical mentalization operative at any given moment.

The same helical processes and stances apply when listening as an audience member, but with a different dynamic. Under X-I, the sonic surface is interpreted in a relatively automatic way, implicitly hearing unfolding causal events that have motivations and states. I suggest this is typical of everyday listening to music. An X-E stance would interpret sound implicitly without agentive attributions. This might be immersion in the evental flow of sound.

In engaged listening (such as an electroacoustic concert) the C-I and C-E stances are likely to be most active. Under C-I, the stance explicitly attends to behaviours and motivated agents. Under C-E, the listener might take a more analytic stance, focused on describable sensory characteristics for example reflecting upon the sound quality, the handling of form, particular aspects of techne, such as choice of synthesis.

As Ian Cross has suggested, listening is a form of behaving – most obviously in felt musicogenic meanings entrained under X-E; however, operating under C-E, I may move my head in order to appraise the details of spatialisation, or I may voluntarily shift to a different stance (as happens in 'composed listening' (Norman 1996). The listener may be taken along with the reception stream (X-I and/or X-E) in a kind of reverie, or move into a more explicit reflective state (under C-I and/or C-E). Within C-stance I suggest we find the listening modes described in the EA literature, any of which might be adopted, informed by the listener's experience with EAM.

The final situation I shall discuss is the composer-performer-listener (CPL) – and I have in mind live-electronic improvisation as the exemplary case. The CPL may tend towards a state of flow. This would be typical of the skilled instrumentalist rapidly acting in response to the changing musical situation, and drawing upon their well-learnt repertoire of motor programs and contextual musical knowledge switching around a variety of stances. During performance, the CPL can move within C stances. Under C-E, the CPL is attending explicitly to (non-mentalizing) technical tasks, e.g. selecting presets, writing live code, optimising loudness. Under C-I the CPL is more concerned with the agentive motivated behavioural states of the sounding surface – the music now seems tranquil, sad, or tentative.

⁂

There is no sovereign listening subject transcendentally outside of a sounding and eventful world. Listening is fractionable, and never simply perceptual, but rather is a performative practice linked to exploratory action and consequence. It co-constructs itself and the world through a peculiar mode of focusing attention, recruiting intentionality and is sensitised to sound and music as socially agentive interlocutors. It is marked through its visceral affective power and by the traces that sound leaves as an audible. It simultaneously apprehends the motivated agency of that sounding, and is constructed by evental flows from which it erupts.

When listening is applied to particular places and circumstances, this exploratory feeling-thinking-acting-sounding expands, the listener PSM vectorially exchanges with the world PSM, a triple pulsation of reception, interpretation and action responding to and causing change through distributed enaction. The listening-composing mind emerges as a self- and world-modelling node emergent within a wider BPS system, as an oscillation between centripetal and centrifugal neurodynamics, complicity shaped by and shaping anonymous materialities.

Chapter 4

Composing perspectives

The previous chapter focused primarily on neurocognitive perspectives by which the experience of being a musically cognising listener in a material world emerges, establishing key models and tools for a BPS_paC, resonant with the position that: 'cognition grasps a real that is not of its own making, and that its capacities may be reshaped as a function of that real' (Mackay *et al.*, 2014: 2–3).

The post-acousmatic, as an epistemic practice of not-knowing in relation to the organisation of events, benefits by taking account of wider cultural and technosocial developments. Musically organised sound is equally constituted by suprapersonal, transgenerational socio-cultural practices and processes. Trace is inscribed through listening habits linked to cultural norms, which constitute hierarchies of power, and aesthetic regimens. Trace may also be materially inscribed through artefactual objects such as musical instruments, physical practice contexts (like zaouias[66]), and a variety of technologies (such as cassette tapes, or the internet).

Thinking the social of music is itself an enormous undertaking that this account will not do justice to. While it is tempting to mobilise the traditional macrosocial tropes of musicology and sociology such as class, race, gender and so forth, recent critical sociology positions place those under suspicion as useful analytics (see for example the discussions in Born, 2005; 2011 and Hennion, 2003). These macrosocial entities are themselves constructions that emerge from multiple mediations.

In this chapter I will revisit the spectrotemporal – auditory object as sign relation, as well as apophenic perception through which compositional action may be said to form chimerae

[66] See Glossary.

capable of transiting and shape shifting, and I link this to the possible confounding of habitual listening reception norms. This in turn amounts to an art-activist stance that seeks to disrupt established aesthetic regimens. Beyond the general BPS processes and architectures that subserve the capacities to music, that create the conditions of musical experience, I take a particular perspective as a composer engaged with the specific conditions in which I find myself. As such, others may formulate different orientations to these general BPS processes.

I will look at network mediation models to develop an account of composition as an engineering of disparate, heterogeneous processes and materials that plug together and construct assemblages whose primary function is the production of sonic surface. I close by considering experimental cultures which produce 'new epistemic things' that link to the 'not-knowing' stance advocated in this writing.

❊

As a practice in which technological and aesthetic innovation is linked, we can move to re-engineer experience through the auditive domain as a critical practice. Thinking must be wary of how it inevitably ventriloquises and territorializes sound; how it is complicit with wider aesthetic regimes of control and normativity; and how it risks effacing sonorities' specificity. Not-knowing seeks to suspend presupposition and takes up an open stance towards sounding events, resisting composition that fetishizes regimes of listening and believing itself to be speaking from sound-itself, as an autonomous theorising and organising of sound thought only from a subject-givenness.

4.1 Topological transit: from morphology to chimerization

Over this and the following two sections, I interweave strands from Chapters 2 and 3, bringing them to bear on the 'desubjectivization', 'de/naturalisation of the ear', 'broken magic' and 'anticommunication' that were discussed in Section 2.2.3 as disruption of perceptual-aesthetic norms. I develop an idea of composing AO signs that transit between locations in a spectrotemporal topology, producing chimerae whose heterogeneity offers opacities to listening introspection.

To quickly recapitulate the relevant earlier points, the necessary vehicle for musicking (through the operations of the K-matrix and RIA-helix) is the reception of acoustic energy into spectrotemporally encoded biosignal. Through centripetal and centrifugal processing, the ST may emergently cohere into distinguishable AOs. These in turn may operate as conceptual signs as well as conveying non-conceptual embodied 'meanings'. We have seen that gesture is passed contagiously and presemiotically (prior to this conceptual structure) through the interpersonal manifold, and may combine to produce semantic signs.

Through the sonic-surface and neural-social manifold interpersonal, geometric relations between observer and observed, listener and socially-agentive music are both symmetrically merged and asymmetrically differentiated. These underpin the mimetic contagion of gesture (symmetric relation) and the reflective differentiation of response, through interposing cognitions (asymmetric relation).

Thinking with Mazzola (amongst others), gesture is at root an embodied muscular aiming at an object, a spatiotemporal pointing towards, caught symmetrically through the we-centric manifold. His 'functor' is the total set of possible perspectives, points of view upon, observable behaviours of the sound-itself. Sound-itself can only be known through its functor. Whatever it may be in-itself, it is metaphysically withdrawn[67] (Bryant, Srnicek and Harman, 2011). Thinking the BPS_paC with Mazzola's topological model of music, the spectrotemporal substrate of AOs can be considered as:

> […] a rubber sheet. Its geometry is that of a rubber sheet capable of bending, twisting and continuous transformation or deformation without its essential properties being changed or disturbed (Negarestani, 2013: 200).

[67] In Peircean terms, we might say that Sign is abductively modelled through the relation of Object and Interpretant (see Figure 11A). Functor then gives the total set of interpretation and action streams.

AOs then arise perceptually as such 'bends' and 'twists' in the ST topology. Negarestani suggests a 'topological reasoning' that he refers to as 'chimera's den' (ibid). His notion of chimera is an analytic, developed in relation to Florian Hecker's use of computational scene analysis algorithms (visual and auditory) that fracture and redeploy perceptual objects, thus drawing attention to the binding of sensory information into coherent trace. I think we can usefully generalise this notion of chimera by revisiting Albert Bregman's often overlooked term.

> [Music often wants] the listener to accept the simultaneous roll of the drum, clash of the cymbal, and brief pulse of noise from the woodwinds as a single coherent event with its own striking properties. The sound is chimeric in the sense that it does not belong to any single environmental object (Bregman, 1990: 460, after Scheirer, 1996: 3).

Musical chimerae are composed fusions of heterogonous source-causes, different elements operating together to form larger-scale AOs that are perceived to have global properties such as 'orchestral timbre', 'melodic implication' and so on.

> It is the combined and continuing experience of these 'chimeric' objects which gives the music its particular quality in the large – that is, what the music 'sounds like' on a global level (Bregman, 1990: 460, after Scheirer, 1996: 3).

There are three themes in Negarestani's discussion that are relevant here. The first, which is well known in EAM, draws from his analogy of composition as a snakes and ladders board organised in a grid. Rather than axiomatically mapping music to the board's squares, (for example, the discrete metrical and diatonically pitched grid that Trevor Wishart (1996) critiques), these 'bound cells' are simply specific identities, marks that locate 'topological neighbourhoods', 'local profiles' that 'are interwoven together by means of the continuity … of the game space itself' (Negarestani, 2013: 200). Composition, of course, need not be confined to these bound cells, to a determinism based upon traditional localisms of diatonic pitch, metrical time and so on, within the topology.

The second is his development of the image contained in Bregman's concept. He generalises the chimera, which becomes a malleable and shifting entity that might appear at a locale, only to disappear and reappear at other locales. In Negarestani's inimitable nomenclature, chimera might appear as a 'goat' (Go@, or game player at a specific locale[68]), where its constituent parts form a perceptually coherent homogenous entity, an AO category materialising at a particular address, mark or identity in the ST topos, 'irreducible into perceptually smaller units' (Schemer, 1996: 3), commensurate with Bregman's original usage. This 'goat' is then the chimera appearing as specific and categorisable AO sign.

The chimera, 'posed a threat to the metric reasoning of the composer' (ibid: 202). It is a creature composed of 'heterogeneous or incommensurable objects' (Negarestani, 2013: 202), part goat, lion and snake:

> […] whose voice was a composition of various animal vocalisations glued together according to their internal consistencies, continuities between manners of articulation, their relations to their ambient space and various swaps and transfers between – a universal composition at the same time irreducible to discrete voices and transcending their cacophonic conjunction (ibid: 202).

While chimera might localise as an identifiable AO sign, it might also leak out across the ST terrain, it:

> […] loosens the lattice and opens up counterintuitive transit passages through and between topological neighbourhoods or environments of the real (ibid: 203).

Chimera then becomes an entity that morphologically transmutes. For example (thinking of the AO characteristics of Box 2) it may be a specific composition in the topological space, but one that can 'frolic and climb vertiginous precipices' transiting outside of axiomatic compositional processes (ibid: 204). This malleable capacity of AOs to transform and deform the warp and weft of sound is well described. For example, metamorphic aspects of compositional activity that shift shape and space are captured in spectromorphological and space-form approaches to acousmatic music (Smalley, 1997; 2007). However, in this acousmatic approach, the activities of chimerae are usually predicated on the perceptually

[68] His terminology is taken from Mazzola's topological mathematical approach to music (Mazzola 2002).

resolvable, bound by the 'sensorily or culturally accustomed range' discussed in Section 3.6 (Ojala, 2009: 419).

Considering composition primarily as chimerical transit, rather than spectromorphological or semiotic development, has considerable 'analytico-synthetic powers' that I think build upon the latter (ibid: 203).

1. Through compositional techniques, the chimeric AO might bind alternative images within a given composition, transiting within a continuous ST environment, appearing and disappearing at specific locals (coherent AO signs) thus expanding its reference space.

2. By subsequently deforming, twisting and interleaving alternative locale profiles within the ST plane together, the chimeric AO possesses a limitless capacity for perturbations and further syntheses, as it transits the ST plane. These transits need not, by necessity, respect Ojala's 'accustomed range', or Schaeffer's 'authentic' or semiotic relation of sign and referent.

3. By fusing, incorporating, indexing and symbolising 'extraneous' (i.e. extra-musical) entities through underlying continuities between various local ST fields, non-local modes of synthesis between incommensurable elements might trace shared boundaries between different AOs, thus drawing topological equivalences and differences.

This chimera is fickle and metamorphic. It might cohere into an AO (appearing as a 'goat') thus signing a specific locale in the ST topos, only to transit elsewhere. It might then transmogrify and destabilize semiotic variations, shifting between or 'modalizing' sign qualities (Negarestani, 2013: 203). Equally, its transits may be so rapid, resistant or opaque to RIA-modelling and K-matrix processing that it challenges the sensorily and culturally accustomed range, it defies capture by established aesthetic norms. As a compositional thinking, it need not respect perceptual horizons, or coherent acousmatic aesthetic illusions, and thus pose an opacity to thought and signification.

The third related point is relevant to the subject-object discussion, because of the location of the 'game player' within the same topological space as the game. The ST topology traces exteroceptively received sound in the listener. Any given 'goat' may be 'a particular composition' (ibid: 204) and/or 'a musico-acoustical operator' (ibid: 203); it emerges as a reflectable function within the topology equivalent to a game player – a listener or composer – at a particular address, a mark or trace within the topology. The player of the game is part of the board, rather than an entity that is outside or transcendent to it.

AO as local spectromorphology/space-form captures the ST topology in perception as signs and their behavioural semiotic networks. AO as chimera captures the mobility and transitioning between signs, as well as resistance to conceptual meanings. I suggest that this is determined by the capacities of the K-matrix and RIA-helix to resolve the ST topology. Spectromorphologies are then generally emergent within the confines of the helix. Chimera captures a transitioning that may exceed the modelling capacities of the biosystem. This distinction presages an experimental culture generating the sonic-not-known against the capacities of the RIA-helix and K-matrix.

4.2 Aesthetic regimens and systems of control

In the opening two chapters, after Foucault and Deleuze, aesthetic regimens appear as territories of discourse, codes that articulate and regulate social exchanges of power, meaning and identity. Like Becker's notion of habitus, these appear as apparently naturalised ways of perceiving and constructing understandings which are nonetheless contingent upon cultural norms.

The art historian T.J. Demos refers to a 'long-standing modernist dialectic' by which these regimens can be contested and questioned at the level of trace by disrupting normative codes, with the intention of bringing these to notice by presenting opacities to auditive introspection (Demos, 2010: 57). In his discussion (also of Florian Hecker's work) Demos focuses on the continuous transformation of sounding elements that confound clear figure-ground differentiation as the basis of intelligibility to listening (i.e. chimeric transit, as just discussed):

> […] as if one is witnessing a process of becoming, a spontaneous event occurring live in space that challenges the customs and habits of listening, revealing in its place a realm of the generation of singularity (a uniqueness emerging within a changing, irreducible multiplicity) (Demos, 2010: 57).

These singularities are the results of chimeric transits of the sort just described in Section 4.1, that may challenge and disrupt referential sign qualities of AOs. Demos draws a parallel between stochastic synthesis techniques and the chance procedures of the historic avant-garde (such as Marcel Duchamp, Kurt Schwitters and Jean Arp), directed against 'systems of standardisation' and, 'more recently reconfigured modes of control and participatory systems of advanced capitalism' (ibid: 57).

To effect this challenge to sound recognition and the language of description, Demos mobilises Steve Goodman's 'unsound' where 'auditory sensation […] [exceeds] […] the zone of cultural expectation and conventional apprehension' (ibid: 58)[69]. This echoes Ojala's point about sensory and cultural ranges operating as limit cases for musical semiosis. However, by 'withdrawing the familiar auditory environment from one's grasp' (ibid: 58), Demos arrives at a 'desubjectivization' of the listener, rather than a ruling out of such strategies as simply incomprehensible. Hence, rather than linguisticity forming a necessary limit to practice (resonant with Kim-Cohen in Chapter 2), this estrangement and reorganisation of sensory experience through the experimental composition of artistic environments transforms what might be taken as noise ('what is typically ignored as nonsense, as non-signifying sonic distraction' ibid: 58) into a questioning of the listening apparatus itself, drawing the limits of the listening 'subject' itself into focus.

[69] This was discussed in Section 2.2.3 'Experience and the conditions of experience' in relation to viscerality.

In terms of my Chapter 3 discussion, this aestheticising of visceral and non-signifying cochleal trace is not concerned with 'beauty'. Rather it 'enacts what Jacques Rancière terms the "redistribution of the sensible", proposing a new mode of being within a reorganised sensory environment' (Rancière, 2004, after ibid: 59). It promotes the art-object as an affective, contagious, agentive presence, exerting effects in its vicinity, where alien presences prompt reinventions of the experience of perception through their opacities and ruptures of habitual modelling.

There is a further distinction within the neurocognitive processing of feeling and emotions that is relevant here. Visceral trace is psychophysiological response to stimuli that is largely unconscious, but may cross into felt-sensations (Damasio, 1999; Damasio and Rudrauf, 2005; Habibi and Damasio, 2014). These somatic markers in turn are evaluated (through the thalamocortical re-entry shown in Appendix A2.02) and conceptually coded into emotions. I suggest that this provides the BPS grounding for what Demos terms 'affect' which:

> [...] modulates bodily responses at a sub-individual level, prior and alternative to language and to intellectual categorisation – the conventional languages, psychological categories and emotional classifications that structure the subject (ibid: 59).

This formulation bridges between the scientific accounts of Chapter 3 into the more sociocritically engaged stance that I take in this chapter, and is evident in the works discussed in Part 2 of this writing.

Through the art-activism stance discussed by Brian Massumi (deriving from the Deleuzian 'society of control'), Demos articulates the deployment of affect at the political level through governmental–media control, where the two processes operate in tandem, promulgating a climate of fear in which the war on terror and state security systems operate (Deleuze, 1992; Massumi, 2011). In this view, affect as a precognitive and contagious force operating in a pervasive fashion across and between bodies and permeating through society. Art and activism then aim at 'alternative regimes of affect that challenge this dominant system' (ibid: 59).

Demos argues that such art–activisms might operate in the geopolitical context of encroaching fear, mass consumerism and commodified entertainment, as disruptive strategies with respect to such aesthetic regimens. Similarly, the compositional use of complex and ambivalent affect might:

> […] invok[e] both attentive curiosity, humour and auditory pleasure, as well as corporeal dread, alarming fear, even nausea (ibid: 59).

The point is to propose work that:

> […] intervenes in ways of being via the reorganisation of the sonic environment […] an unlearning of musical codes and […] patterns of hearing in favour of an experimental becoming (ibid: 59).

Such strategies foreground a key challenge of our times playing out:

> […] a confrontation between participation and control, one that engages the legacy of the conflicts within and between […] the freedom of collaborative events and the technocratic structuring of sensory existence […] A space of perceptual sensitivity to the unsound that becomes a realm of possibility (ibid: 60).

These strategies then function as compositional thought that might challenge authoritative discourses and received, commoditised aesthetic norms, such that composition operates as a critical art practice.

4.3 Apophenic process

Pursuing this linkage between the sociocultural construction of habitual aesthetic regimens, I turn to Robin Mackay who, again discussing Hecker's work, posits an 'hallucinatory mode' of perception as an analytic to unlock perceptually disunified and malformed auditory objects; the 'broken impressions', that are conveyed in Hecker's electroacoustic practice (Mackay, 2010). While his approach is powerfully cogent, I suggest that he is over reliant on the historic development of, and metaphorical use of, the term 'hallucination'.

For the reasons already discussed in Section 3.3.2, I think it is more accurate to think of an 'apophenic' mode or process of perception. Apophenia captures the transitional continuity between hallucination proper and quotidian perception, and, freed from associations with mystic visionaries, psychotics, occultists and other marginalised modes of being, is not necessarily pathological, and even 'universally characteristic of the human species' (Fyfe et al., 2008: 1316).

In the previous chapter I called this the apophenic mode of perception. Not only is apophenic more accurate than hallucinatory[70], as a descriptive term, it usefully connects Mackay's analysis to wider territories, such as Matteo Meschiari who uses the apophenic to propose the role of prehistoric landscape and ecosystem in shaping the cognitive capacities of early homo sapiens 'savage mind' (Meschiari, 2009: 3). While the 'hallucinatory' might capture something untamed and uncoupled between perceiver and environment, it implies a perceiver solipsistically trapped in interiority, with no access to a real beyond itself. Apophenic mode, however, offers an account of a shifting dynamical balance between fantasy and reality, and between mentalizing interiority and exteriority.

4.4 Heterogeneous engineering and sonic assemblage

This section concretises my proposal for a BPS_paC by considering a cybernetically informed compositional perspective, notions of mediation and contingency, and the BPS concepts already outlined, to suggest that a variety of disparate processes can be assembled as a system for musicking, that is, to compose a sonic assemblage.

Herbert Brün's formulation of composition as activity within a system of embedded systems is useful to bear in mind:

> I use the word 'composition' whenever I wish to speak of the composer's activity and the traces left by it. The composer's activity is motivated by a wish of bringing about that which without him and human interest would not happen. In particular, the composer's activity

[70] Unless we are really talking about fixed, false perceptions that are genuinely believed occurring in the absence of a cause external to the perceiver (Simms, 1995).

consists in constructing contexts, systems, stipulated universes, wherein objects and statements, selected by the composer, not only manifest more than their mere existence, but have a function or value or sense or meaning which without his construction they would not have had. Occasionally the composer's activity brings about that which without him and without human interest could not have happened, leaving traces which nothing else could have left (Brün, 2004 (1970): 54).

The activities of composition are only evident because they bring about causal events that may leave traces[71] because of the motivated intentions of a composer that engages sociality. In Metzingerian terms, we might say that motivated intentional content is what a particular compositional system's activities are directed at. As a self- and world-modelling agent, the composer PSM represents its relation to culturosocial systems of meaning by pulsating in and out of a causal interaction space, imaginatively generating a sonic model that (potentially or actually) engages others. Accepting O'Callaghan's *Relational Event View* as a premise, then (medium aside) the composer system's activities are directed at (model) the organisation of material causal events with respect to the organisation of perceivers. While the latter was the focus of the previous chapter, here, a more focused modelling of the social is helpful.

The Deleuzian term 'assemblage' has appeared several times and derives from cybernetic and systems thinking (Weinbaum, 2015). While it carries resonance with words such as 'collage' or 'collection', meaning to group items or elements together, assemblage implies more than fortuitous bricolage. It has been developed by the materialist historian Manuel DeLanda to think about social complexity, particularly asserting the autonomy of social entities (DeLanda, 2006). In assemblage, entities come into contingent relations rather than forming parts of necessity. It is a:

> […] sort of anti-structural concept that permits the researcher to speak of emergence, heterogeneity, the decentred and the ephemeral in nonetheless ordered social life (Marcus and Saka, 2006: 101).

[71] In addition to visceral, cochleal and the mnemonic developed in Chapter 3, trace includes material inscriptions such as recordings, arrangements, code, scores and so on.

Component parts interacting in open systems may be detached and plugged into different assemblages in which its interactions are different.

The term has proliferated through the social sciences and into EAM, for example in Owen Green (2011), where it frames the complex negotiations between the technical and the social inherent in the practices of making that underpin composition, that is, the construction of artefactual sonic assemblages. It appears in other music scholarship, such as writing on rave culture, psychoactive drugs and techno, and work on music and the materialisation of identity. In common with Actor-Network Theory[72] and the discussion in the previous chapter, assemblage theory understands social entities as agentive actants. That is, technosocial processes (themselves comprised of a variety of subsystems and mediations) can cohere together to exert a cohesive effect as a unity.

The approach eschews the standard tropes of music sociology such as broad notions of race, class, gender, authenticity, production and consumption, resistance and acquiescence and so on. Instead, the social in music is regarded as a constellation of mediations that chain and bring about these notions as effects. These mediations are:

> [Plural] socialities engendered by musical practice and experience … [and] social and institutional conditions that afford certain kinds of musical practice (Born, 2011: 376).

Georgina Born's study of the jazz assemblage (Born, 2005) and her book on IRCAM and computer music, illustrate this approach and are superb in their depth and detail charting the rise of a certain aesthetic and philosophy of musical modernism 'via the agency

[72] Actor-Network Theory (ANT) is most associated with Bruno Latour, and has been influentially applied to music studies by Antoine Hennion and Georgina Born (Latour, 2005; Hennion, 2003; Born, 2005). ANT emanated from the sociology of science, and has extended to offer a world full of cognitive objects. These actors operate materially, coming in and out of coherence to form networks that have effects. It is helpful to thinking about humans in relation to technologies and a host of other material entities that enter electroacoustic composition. Within this perspective, words like 'social' and 'cultural' do have utility, but are recognised as 'punctualizations' that efface the complexity of their mediation. Society, organisations, agents and machines are the effects that are generated in these patterned networks of diverse materials operating together. However, these networks can consolidate and come to look like 'punctualized' or 'single point actors' (Cressman, 2009).

of its musical and critical proponents, its social networks and institutional settings, its aesthetic boundaries and discursive contents' (ibid: 15). The social is actualised by assemblage, by networks of mediating elements.

Mediation models of the social resonate with the pragmatic techne of EAM. Objects of various kinds and with various capacities can be plugged into one another in a variety of ways to form network systems. The object-oriented programming (OOP) paradigm that informs some composition software (such as Max/MSP and Supercollider used in my work) is a network of digital graphs that can be configured in a variety of ways inside a computer. In OOP, objects have familial resemblances, inheriting their specific capacities and methods. They can receive from and signal to one another through exchanging messages, but their behaviours are polymorphous; as objects are heterogeneous, they interpret these messages differently. They can be nested into one another, and are often interchangeable, being swopped out to create different consequences (Gamma et al., 1994; Zandbergen, 2016). Crucially, OOP opens out into a world, an environment composed of dissimilar and complex determinants. A code patch is plugged into hardware such as microphones and loudspeakers[73] that plug into performers or concert spaces which are formed by the mediations of curatorial invitations, arts grants, cultural affiliations, the internet, supra-generational musical traditions and so on.

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Over the course of Chapter 3, we encountered a number of heterogeneous concepts: sonic surface, viscerality, secondary coding in auditory object formation, local syntactic dependencies, musicogenic meanings, joint intentionality, coupling, action-streams, mentalizing listening stances, we-centric manifolds, causal interaction spaces and so on. My suggestion is that, as part of compositional model building, they might be amenable to techne

[73] Which are themselves punctualizations, mediating a specific effect (such as recording or diffusing sound), but comprised of various organized circuits, plastic, man-hours, lineages of development and so on.

in albeit differing (heterogeneous) ways. These are all processes that could be theoretically, if not yet practically, brought into contingent relations compositionally.

Composers, musicians and audiences are emergent from their network conditions comprised of the sub, inter, and suprapersonal processes (BPS mediation effects) that I have outlined. Compositional intention plugs into social actors, mediated by biological and psychological processes that combine to produce specific sonic effects. The sonic surface is the end-state caused by composing the activity of a sonic assemblage, as a causal interaction space.

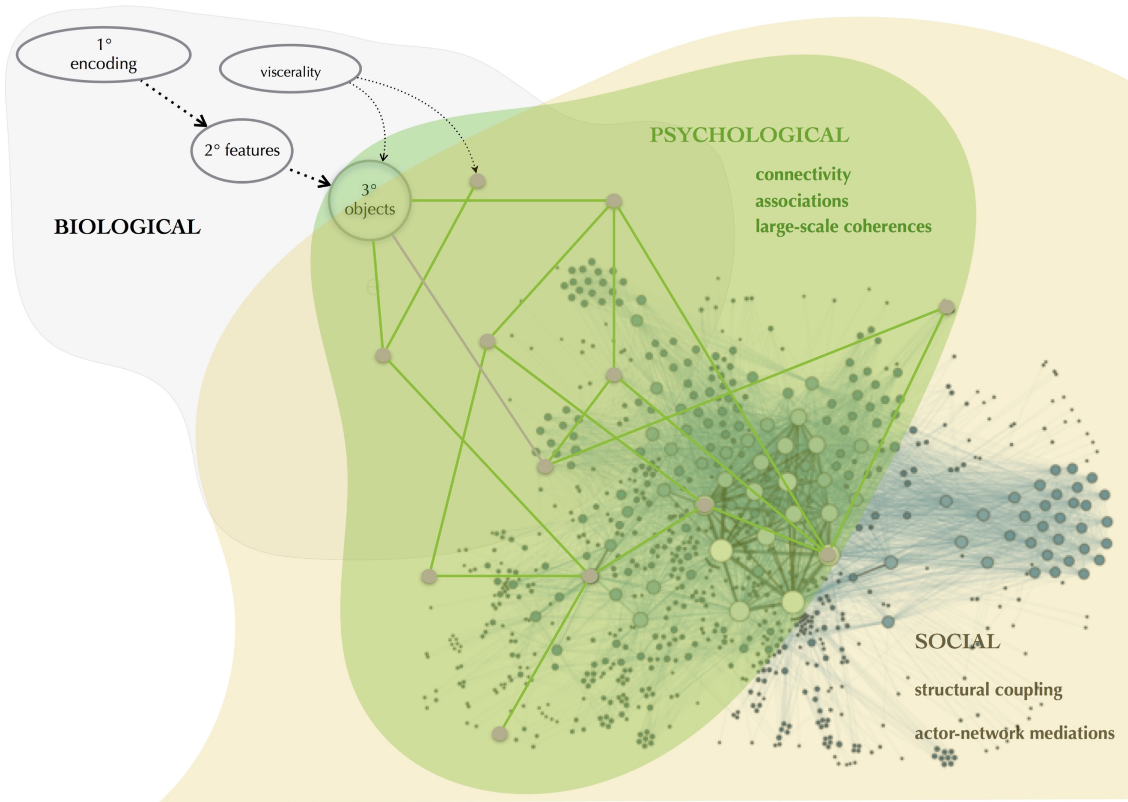

Figure 15: Diagramming the biopsychosocial sonic assemblage

Figure 15 conveys the idea visually, simplifying the massively ramified and rhizomatic interconnectedness between BPS domains. Biological pathways are simplified to show the receptive processes at the sonic surface through viscerality, and primary and secondary coding in the AS, to form auditory objects (only one is shown). AOs ramify cortically, forming larger scale coherences through the LSBNs previously discussed and associative neuropsychological processes (semantics, syntactic dependencies and so on). In neural connectivity analytic terms these connections are topological planes (like the ST plane of secondary auditory encoding) which have edges, that is, they are uncorrelated with other neural activities (Jones, 1981; Gibb, 2001; Ross et al., 2009). These planes are shown as continuous lines in the psychological domain, forming networks that make contact with processes in the social domain, coupling through the interpersonal we-centric manifold, entraining, co-operating, socially and politically affiliating through network mediations. The social is comprised of a host of actor-networks whose mediating effects structurally couple with psychological and biological processes.

The hierarchicality of the natural systems in the BPS paradigm may appear organismic, in that listening and musicking are regarded as emergent from mutually conditioning systems interactions. However, while composing may require functional conditions of BPS systems, it is not a necessity for our BPS well-being; rather, composition can exploit these systems somewhat arbitrarily, forming contingent dependencies between processes teleofunctionally, according to the goals at stake, and depending on the questions motivating the work[74].

Assemblage is useful because it acknowledges the way in which various elements, techniques, processes and concepts can be formed into mutual relations and temporary dependencies. These heterogonous entities can be imaginatively composed into effervescent, on-the-fly coherences (transiting chimerae) that have causal activity. Component parts may be detached and plugged into different assemblages in which their interactions are different.

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Approaching composition as a practice of forming sonically active BPS assemblages, theoretically opens an enormous (and overwhelming) space of possibilities. In practice, the challenge is to constrain a specific assemblage by the selection of key salient elements that are at stake in a given piece, examples of which are given in next two chapters. Here, I shall suggest examples to demonstrate the possible scope.

At the biological level, listening depends on physical events accessible only through physiological processes. These physiological conditions could fall within the scope of techne.

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[74] I mean 'work' in the pragmatic sense of a sound piece, and am mindful of Lydia Goehr's powerful critique of the 'Work Concept' (Goehr, 1992).

One could imagine intervening into the CNS[75], such as the auditory cortices via transcranial magnetic stimulation. The composer could target the peripheral nervous systems (using techniques such as masking, otoacoustic emissions, manipulating basilar membrane interference patterns, interaural time differences). There is an array of psychoacoustic techniques (used widely in EAM) that operate on primary and secondary encoding and manipulating auditory stream fusion and segregation. Music psychology demonstrates a variety of auditory illusions based upon these. Composition could explore the impact of high intensity and very low frequency sound, the physical production of events, acoustics of physical spaces. One can imagine making music for cochlear implants, or induction loops, or using electrophysiological processes such as EEG as a generative source (see for example Brouse, 2012).

At the psychological level, the composer could be interested in the panoply of mental phenomena such as emotional, cognitive, syntactic and semantic aspects that emerge from the sonic assemblage. At the social level, the electroacoustic composer's activities might select, organise and negotiate with a host of actor-networks, perhaps with an art-activist orientation to sociocultural and political issues.

A sonic assemblage can then include access to studios, recording equipment, analog circuits, computers, digital synthesisers, spectrotemporal manipulation of recorded sound files, dub studio techniques, supercollider synthesis patches, basilar membranes, the formation of auditory objects, visceral affects, cognitive and emotional interpretations, conceptual strategies, actualised behavioural responses, imagined continuations, choices of acoustic instruments, the dynamics of an improvising ensemble, structuring interactions and group behaviours through scored compositions, performance locations, Islamic recitation traditions, curatorial fads, institutional funding grants, cultural musical norms, historical

[75] There are clearly pragmatic, technological and ethical limits to this. While a composer cannot directly intervene into the neural organisation of listeners' brains, she might use psychoacoustic techniques that play upon its capacities.

controversies, acousmatic music, free improvisation and political perspectives[76]. Any of these components are potentially admissible to techne and organised into assemblage. This forming is profoundly constructed through the multiple and complex interactions of a variety of systems.

The biopsychosocial (BPS) framework for composing proposed here conceives of an electroacoustic composition as an end-state, a dynamic experiential unity that is emergent from organising causal events through interactions of biological, psychological and social systems. By expanding the social away from organismic necessity, and emphasising instead contingency and mediation, assemblage offers a pragmatic conceptual place-holder which captures the fluidity and provisionality of making that harnesses a range of disciplinary theories and practices.

It therefore emphasises the provisional and iterative nature of composition as an empirical and experimental practice. The role of the composer (who may also be a performer and a listener) is to assemble, to engineer, to orchestrate (or in some way to make happen) contingent relations between heterogonous elements, assembled with respect to (but not necessarily constrained by) auditive experience, in order to create activated sonic surfaces – resulting in assemblages of trace that do something in the listening.

4.5 Experimental culture: new epistemic things

The heterogonous engineering of assemblages opens a practice that is not, by any necessity, bound to conventions of musical praxis. Instead it is free to generate what I term the 'sonic-not-known', new chimeric forms. By proposing a post-acousmatic experimentalism, I have in mind the notion of experimental methods and cultures that operate in the material empirical sciences. The sonic-not-known is not simply raising a question to listening, it aims to produce a new epistemic thing. This experimentalism

[76] The list of elements contributing to any given assemblage is potentially vast, and necessarily tends towards what Ian Bogost calls 'Latour litany' (Bogost 2009).

promotes a playing with reality, an experimentation with what is possible and an exploration of listening through innovation.

The historian of science and microbiologist Hans-Jörg Rheinberger refers to experimental culture as a 'non-technical ensemble of technological objects' (1997: 29). Scientific innovation comes through the emergence of new functions as established tools are reproduced through experimental systems. Rheinberger offers an epistemology of experimentation in which research is a process for producing these new epistemic things:

> […] material entities or processes – physical structures, chemical reactions, biological functions – that constitute the objects of inquiry. As epistemic objects, they present themselves in a characteristic, irreducible vagueness. This vagueness is inevitable because, paradoxically, epistemic things embody what one does not yet know (Rheinberger, 1997: 28).

He emphasises the primacy of the material arrangements of the laboratory, in creating a dynamic system that is a physical, technical and procedural base for experimentation. An experimental system is:

> […] a basic unit of experimental activity combining local, technical, instrumental, institutional, social and epistemic aspects (ibid: 238).

I think his comments speak equally to the condition of electroacoustic composing where the studio or the stage can become exactly such a site where a dynamic system is heterogeneously composed to produce new epistemic things. Rheinberger's emphasis on the assembling of heterogeneous materials points to an epistemology that is never fully separable from their conceptual and physical instantiations (Thieffry, 1999). Electroacoustic musicking highlights this enactive play between interpreting, cognising, knowledge producing creatures and the material and mediated means of sonic production.

4.6 A biopsychosocial approach to post-acousmatic composition, Part 2

In this chapter I extend the sonic materialist approach. Auditive introspection is not removed from the equation but is placed within the same topological plane as its object, no longer transcendent but instead emergent and geometrically related as a form of matter-in-motion. Drawing on the neural encoding of sound's trace, I develop composition as the construction of species of chimera, which traverse a single spectrotemporal topological space, and which might exceed semantic and semiotic intelligibility and the capacities of the K-matrix and RIA-helix to resolve events within the scope of accustomed aesthetic and perceptual norms. This in turn may be a strategy to disrupt settled aesthetic regimens, with a critical art-practice in mind.

The apophenic mode of perception suggests composition as realising imaginative projections onto the world. Or rather, a biosystem transferring trace models from one space into another, within its self- and world-modelling activities. Trace, however, is not entirely in the brain, but is also inscribed into the externally real, exerting its effects through both distributed cognition and punctualizations of material object-mediations. Composition becomes the construction, capturing, trapping, accumulation and deployment of trace through assembling a variety of processes into art objects that exert agency and effects within their vicinity, drawing also on Albert Gell's anthropology of art.

An important consequence is that the listening-composing mind is unshackled from any necessity to respect unified representational processes, and to adhere to governance by such processes. Composition instead becomes an oneiric space of playing with reality, decoupling from practices of creating aesthetic illusions, instead rendering opacities to thought. While I am sympathetic to philosophical realist engagements with sonic arts that celebrate 'hallucinatory modes' that highlight the operations of the ear-brain in the construction of work, apophenia is intermediate between real hallucinations and quotidian perception. My purpose is to allow for a full scope of post-acousmatic practices that engages both sides of the Kantian correlation, sound which can be or move between representational and non-representational operations, both for and in excess of a perceiver.

The BPS_paC, opens into a systems approach more kybernetikoi than the akaousmatikoi or mathematikoi that are often discussed in relation to the phenomenological and formalist distinction in composition (exemplified by Pierre Schaeffer and Iannis Xenakis). Through a not-knowing stance, composition might breed chimerae through experimental practices that generate new epistemic things, the sonic-not-known. It might do so by processes of heterogeneous engineering, assembling all manner of objects together, some internal to the composer (such as mnemonic associations, feeling-sensations, concepts etc.) and some external and material (such as synthesisers, musicians, field recordings, commissions).

Adopting the language of actor-network theory, sonic assemblages - electroacoustic pieces (and listeners and composers) - are punctualized networks, that is, coherences emerging between material intermediating entities that act together as distinguishable entities (Law, 1992; Latour, 2005).

Through our mentalizing capacities to encounter music as an agentive other, listening might begin from a 'not-knowing' stance investigating the vectorial relations between itself and a world through electroacoustic means. Post-acousmatic composition is then heterogeneous experimental engineering, through the assemblage of systems comprised of a variety of trace-bearing elements operating on equal terms (including the corporeal, conceptual, perceptual, motoric, and inanimate) that have the generation of the sonic-not-known as their end-state. In my practice, this is tied to an idea of potentially disrupting settled habits and aesthetic regimens.

The last move in my argument is from the metamorphosis of forms that has characterised acousmatic practices, into processes of chimerization, where the spectrotemporal forms a plane where the materially real and the subjective meet at the confluence of centripetal and centrifugal processes, and which affords transits and passageways that might flip and invert homogenous territorializations of sound, decolonising and deracinating trace by experimental practices that allow for the counter intuitive, and unbinding the habitual.

Part 2: Sounding thinking

(chimerae and assemblage)

A major axis of the discussion emerges here around a Promethean or 'accelerationist' project of the unbinding of imagination, thought and action oriented toward the enhancement of the human. It understands images as providing new modes of epistemic traction by processing sensory data through symbolic formalisms and technological devices. This is not a flight from a supposed bedrock of concrete immediacy to ideal abstractions, but a progressive reorientation to less localised models – the movement towards a 'universal address' reconsidered as a matter of cognitive navigation, and enabled by aesthetic reconfiguration.

If this suggests a disturbing instrumentalisation of aesthetics, again it should be recalled that a leisurely absorption in images, the rush of the sublime, the staging of a multimedia micro-utopian happening, all possess a certain purposiveness, form part of a project, and mandate certain patterns of behaviour. It is incumbent upon us to assess their effects and effectiveness. If we accept that the emancipatory epistemic function of aesthetic practice lies in its ability to undermine urdoxa and to illuminate the socio-cognitive conditioning of experience, it is crucial that this brings with it a commitment to something more than the provocation of moments of alienation or evanescent sentiments of liberation.

This conception breaks with the phantasm of an aesthetic realm that is radically immediate, indeterminate, free of conceptual constraints, or outside all extant power structures; it considers concrete and abstract as relative terms, and the aesthetic and conceptual as inextricably intertwined; and it entails a practice that no longer invests its faith in the essential promise of the aesthetic as such, but instead acknowledges the real force and traction of images, experimentally employing techniques of modelling, formalisation, and presentation so as to simultaneously 'engineer new domains of experience' and map them through a 'reconfigured aesthetics' that is transdisciplinary and indissociable from sociotechnical conditions.

Robin Mackay, Luke Pendrell, James Traford. Introduction in *Speculative Aesthetics*. Urbanomic (2014: 6)

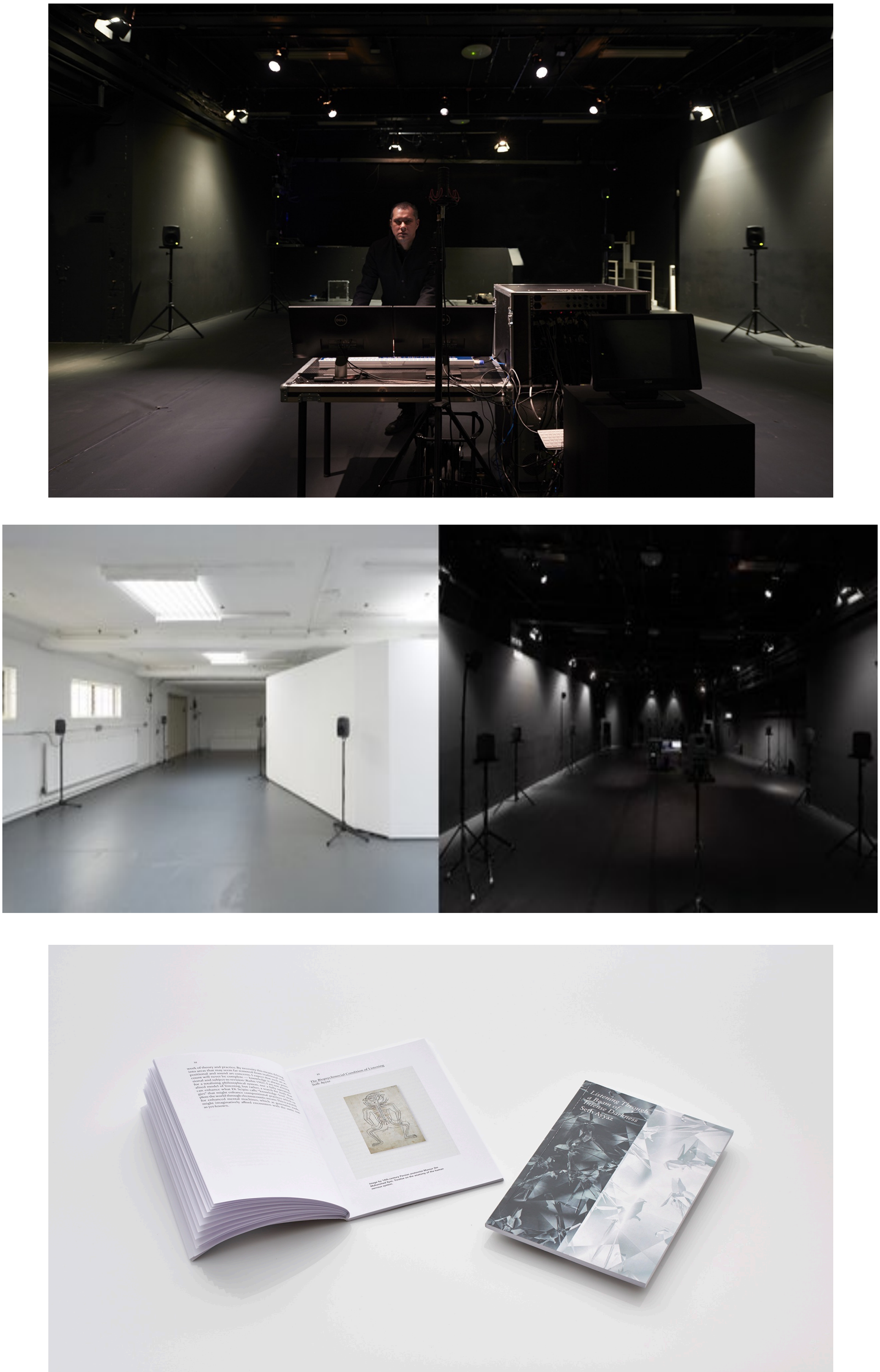

Figure 16: *Listening Through a Beam of Intense Darkness*, solo exhibition at fig-2, Institute of Contemporary Arts, London, December 2015

Chapter 5

What can a sonic assemblage do?

5.1 Assembling trace

Whereas Part 1 offered a thinking of sound through the generalities of biopsychosocial processes, Part 2 proposes composition as sonic thinking from trace's specificities. Science tends towards observing and accounting for the quotidian, seeking general principles and axioms, whereas art seeks singularities. By travelling and working in the MENASA I encountered very particular practices and contexts, and captured highly specific trace as field recordings. These experiences and the questions arising from them lead to the work of the earlier chapters.

The triptych of fixed works submitted is discussed here in relation to the ideas of Part 1. Rather than arising with 'a conceptual apparatus already in place' (Cox, 2016: para 16), they emerged through re-entrant circulations between sounds that I encountered, constructed and assembled, and the developing BPS framework. These pieces sound thinking in differing ways, both initiating and responding to aspects of the BPS_paC.

As will be apparent from my formulation of trace, and a not-knowing stance, I am wary of linguistic attributions that over-code communication about sound. The final arbiter will be the effects that these sonic assemblages exert on listeners in their vicinity. In general, this experience is caught between the causes and effects of both listener and composer (Brün, 2004). As such, I will focus on my intentions as proximal cause and encourage 'anti-communication', leaving the potential terrains of reception and interpretation open to the listener (Brün, 1995a: 478). I will avoid directing listeners towards any 'authentic' or 'proper' way of receiving these art-objects. With that caveat in mind, I am specific about my compositional processes, and investment in capturing and assembling episodic traces[77] into activated configurations.

BGZ and *Makharej* arose early in the research and deal with interiorities, with cultural signs tied to linguisticity and to contesting specific aesthetic regimens and cultural meanings. They address a notional 'Islamic sonic-social' operating interstitially between 'occident' and 'orient'. Both investigate the transcendentally ideal listener, which is also presupposed in Islamic theological debates regarding the ethico-aesthetic role of listening, the permissibility of music and the divine authority of the Arabic language. These works somewhat polemically address this subject as discussed in Part 1, but from the perspective of my engagement with recent geopolitical contexts.

The Remainder completes this triptych, in parallel with my interest in organising trace according to evental exteriorities, and algorithm. It moves towards decentring the subject. While *BGZ* makes extensive use of referential field recordings, and *Makharej* presents the embodied subject adrift in an anonymous noumenality, in *The Remainder* the subject has largely gone (save for residual traces of breath). It is loosely organised through mathematico-algorithmic considerations, and arranged (via Xenakis's 'epiphenomenon') intuitively by introspections into RIA modelling in the studio.

5.2 On the admissibility of sound as music and art

> The Demons are said to learn the secrets of the future by listening behind the veil (Cheragh Ali, 1885: xxxvii).

In December 2015, I presented a solo show at fig-2/ICA called *Listening Through a Beam of Intense Darkness (LTaBoID)*. It included the triptych *On the Admissibility of Sound as Music and Art*. This title derives from Al-Ghazzali's transcendental writings on the moral admissibility of listening to music, a sense of which is given in Figure 17 (Al-Ghazzali, 2003).

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[77] As discussed in Section 3.3.3, 'Episodic trace is linked to our listening biographies, to the contexts of times, places, emotions and personal significances'.

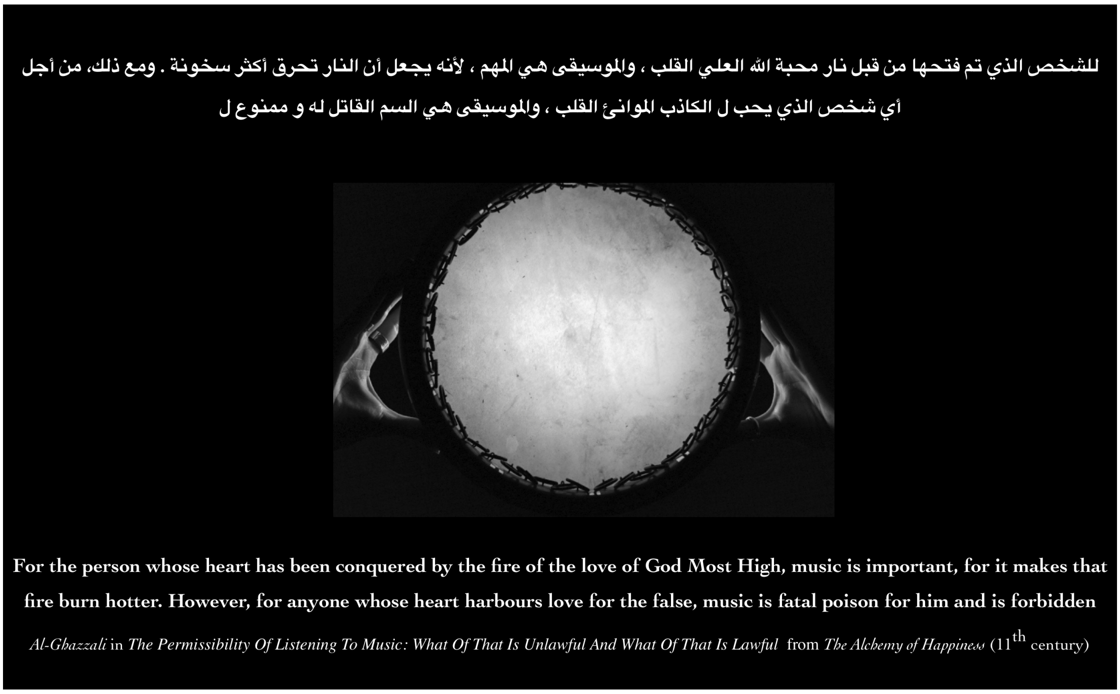

Figure 17: The poison of belief in the Necessary Being (Seth Ayyaz 2011)

In contrast, the title *LTaBoID* derives from Bion (Section 2.3.1) and the Metzingerian eliminativist account (Section 3.2). Post-acousmatic practice as an epistemic tool might raise questions, highlighting the 'not-knowing' stance as a special kind of darkness that presents opacities to introspection.

The triptych invokes an 'Islamic sonic social' a term that I intend to capture trace as both constitutive of and constructed by specific sociocultural contexts (discussed in a different register in Chapter 3), specifically in relation to Islamic historical, cultural and religious practices. An obvious example is the function of the *adhan*, as a potent marker of difference and disciplining power.

There is no single 'Islamic sonic social' – Cairo is different from Jogyakarta, from Bradford, or from the romanticism of Jihadist videos. I am not simply referring to characteristic soundmarks, but also ways of listening, sensibilities, habitus, aesthetic regimens. Listening is inscribed with and fulfilled by expectancies, affectively invested with centrifugal phantasy and projection. In the Islamic context, an 'ethically-honed sensorium' is the habitus of listening to sermons and Qur'anic texts inscribing piety in the listener (Hirschkind, 1987; 2001).

The triptych contests semantic signs and sociocultural aspects of trace, informed by aesthetic traditions, and their intercultural representations, constructions and tensions. I have no interest in promoting certain religious values, but take issue with them. These pieces also comment on sonic orientalism that uses trace to index exotic alterity. I tease out and amplify problematics. Rather than an endless post-modern deferment or acousmatic bracketing of meaning, I take a position, hoping to demonstrate a post-acousmatic critical practice.

These specific socio-political aspects are discussed mostly in Section 4.3. Especially in *BGZ* and *Makharej,* trace is composed emphasising AOs as conceptual signs, and their visceral aspects that generate particular affects[78] (and effects on the listener). Key conceptual, socio-cultural and historical components were assembled, heterogeneously engineered, their agencies mediated in the studio through various electroacoustic means, and further activated by the contexts of their performance. As fixed pieces, they are intended to punctualize into agentive art objects. Their listening end-states have a polemical tone that engages the messier political aspects of the current human nexus, performing a definite 'bracketing in' of ramified associations and interiorities (C-I). However, strategies are employed that emphasise the visceral exteriority (X-E) of trace.

These pieces intend to present opacities, drawing reflective awareness to undermine specific assumptions and orthodoxies and to critique the sonic sociopolitical world. They are intended to mobilise listening as conceptual, affective and motoric, as well as sensory, in order to disrupt aesthetic regimens, each with a specific concern: ethics/place/religious debates; the authority of letter/the transcendentally ideal subject; and number/algorithm.

[78] Particularly anxiety, fearfulness and ambivalence, which comments on the current climate of suspicion in relation to Islam.

Electroacoustic techniques of sound analysis, synthesis and spatialisation are brought to bear on traditional Islamic concerns such as the ethical admissibility of music, adhan, the recitation of Qur'an, voice, and number theory applied to pitch organisation and rhythm.

Working with charged and specific culturally located materials reinforced my questioning regarding the theoretical foundations of acousmatic practice and soundscape. If aesthetic practice takes seriously the interrogation of urdoxa, and harnesses trace to capture flows and exert force, post-acousmatic practices might become more than the construction of aesthetic illusions.

5.3 The bird ghost at the zaouia

Figure 18: Thomas Qualmann, *the bird ghost at the zaouia*, 2011, commissioned by Seth Ayyaz

BGZ is a 7.1 channel fixed piece based on field recordings made across the MENASA in Islamic religious ritual contexts. It exists as an installation and a shorter concert version (the latter is submitted).

I was struck by two key features of the traces I encountered. Firstly, their contagious affective power which structures people's daily activities in parts of the region. Secondly, by the specific aesthetic regimens associated with the 'ethically-honed sensorium'; disciplines such as *tajwid* and *tilawa*[79] associated with listening reception; and, theological arguments over the admissibility of sound as *halal* or *haram*, described by Kristina Nelson as the '*sama'* polemic' (Hirschkind, 2001; Nelson, 2001).

The contested moral status and definitions of music between vying schools of Sharia (the sama' polemic) gave rise to my compositional strategy of excluding recognisable 'musical' elements, working only with residual traces. The work, perhaps paradoxically, makes music by using trace excluded by religious injunctions. As such the field recordings became a site of comment, open to a range of possible reconfigurations.

BGZ initiated and responds to a number of the themes of Part 1. The assemblage (Figure 19) particularly responds to questions of the transcendent ear; contesting the authority of aesthetic regimens (within the Islamic cultural context and between orient and occident); and the symbolic and culturally referential composition of trace. The sonic outcome exists in two versions: concert and installation, which I have discussed in detail elsewhere (Bhunnoo, 2011). Further background information, including related artwork, and installation images can be found in Appendix A1.02.

✲

To make these connections somewhat more concrete, I shall outline the opening seven minutes of *BGZ*. Initial pitched voicing indexes a human presence, occur intermittently, at times clearly truncated. Something is missing. The recitation of the Qur'an, and the related *adhan* are highly regulated practices, subject to *ahkam al-tajwid*, a system of divine authority

[79] See *Glossary*.

that governs correct recitation such as the handling of pauses (*waqf*) and resumption (*ibda*ʾ).

Throughout *BGZ*, recorded fragments appear that immediately precede or follow recitation, affording a play with listener expectation. The sonic-social signification is not directly represented, but traced (an in-breath, exhalation, pause, pitched reverberation immediately following the voice in the space) as an expectation that human-divine agency is immanent, never quite actually present.

In the opening moments, the expectation of voice dissolves and a veil of abstract high frequencies, composed of tiny fragments of bird song appears, whose spectra slowly expands. It hangs in 'no-space', with little perspectival depth, or reverberant space around it. It is entirely artificial, and rather static, potentially throwing out the listener by its apparent lack of eventfulness, but rewarding attention to local dependencies, just-noticeable differences of intensities and pitch, inviting a reflective listening stance. It presents an immersive texture exploring temporal suspension, a challenge to gestural, narrative listening, setting up a soundscape not quite of this world.

In fact, a number of 'real' spaces are already present, the perceptual balance shifting from foregrounded veil to the resonances of the tomb of the Sultan Hassan Madrassa in Cairo in 2010. Indices of the human vie for salience, barely perceptible, placed at the threshold of listening. Transient voices argue in Arabic. For me as composer this episodic trace is a moment when recording (with consent) an Imam giving the Friday adhan. We were interrupted by the religious police and an argument ensued with my colleague over the permissibility of making such a recording (due to the *sama'* polemic). I was to be arrested, but the intervention of the Grand Sheikh reversed the situation. I was told that it was my religious duty to complete the recording. These associative details will not be known to most listeners, but may be inferable for an appropriately enculturated listener. It is included as a reference to the key issue at stake, transparent as an index of emotion, symbolic of a general contemporary geopolitical situation, but opaque in its specific detail for many listeners.

A balance point in auditive introspection is explored – to listen with 'acousmatic' ears for structural signification and onwards development of sound objects (C-E/C-I), or to give oneself over to texture and time passing (X-E, C-E). Entities disturb and mark the sonic surface. Some are momentarily recognisable – a pitched voice intoning that occupies a fixed, specific, 'real' space and position, only to recede and return, pivoting the listener in and out of immersion and auditory focus, speculative exteriorities and interiorities.

The ears sensitize or habituate to the frequency range before the interior spaces, that have been distantly present throughout, develop into a fuller spectrum and resonant event. As a perceptual threshold is crossed into the realisation of a specific AO, the spectrum rapidly fills; a thunderous impact is heard as the doors to the tomb are closed (possibly a semantic reference to the closing of the gates of reason?) unexpectedly bringing another space into being, paired with a noisy close presence and footsteps receding. Similar transits recur throughout the piece, but different in specific detail, a recurring crescendo-expanding spectromorphology, but its internal constituents are substituted, exchanging night insects, or oasis water sounds for birds.

5.3.1 Assemblage

Figure 19 shows the key elements of the assemblage. *BGZ* engages at the intersection of 'world' music, soundscape composition, and the aesthetic appropriation of sonic-social signs. Islamic aural practices (mostly *aðhan*, *ðhikr*, *zar* and *lilat*)[80] were recorded, and their traces re-sited into a new sonic assemblage. Conceptually, the assemblage (top-right) engages culturally and historically specific issues. The permissibility of music under different schools of Sharia is a well-known debate. In brief, two poles operate – a (broadly) Sufi perspective that argues for music (under *halal* conditions) as spiritual and prayerful practice, through to a puritanical view that holds that music of any kind is intrinsically blasphemous and an

[80] See Glossary.

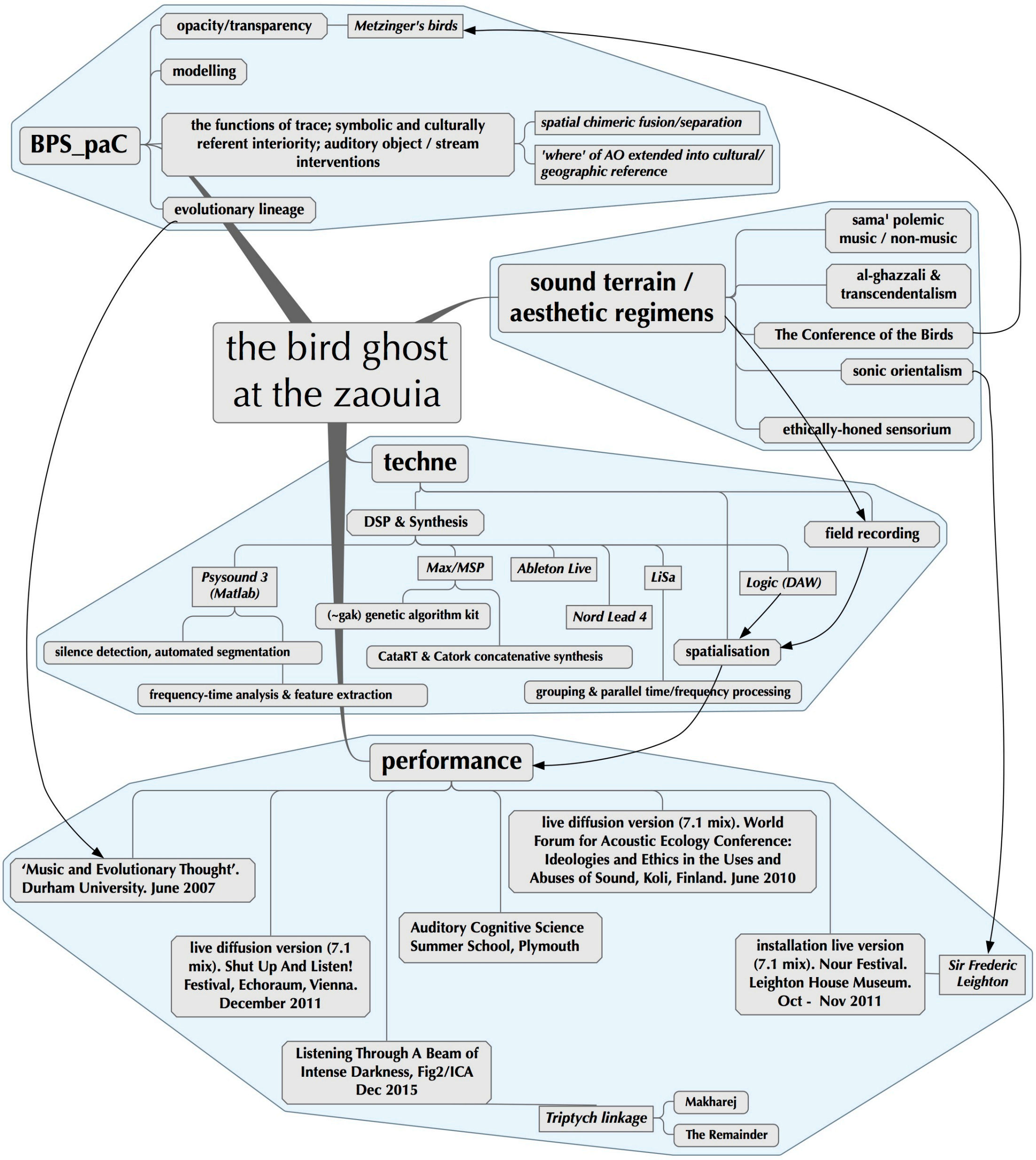

Figure 19: Key elements of *the bird ghost at the zaouia* assemblage

invitation to sin. Between the conditionally inclusive, and the outright injunctive is the most contested arena. Practices such as *tilawa* (Qur'anic recitation), and *adhan* receive a special categorisation as prayer and not music despite the often highly pitch and rhythmically elaborated improvisatory styles that have invited an aesthetic and musical listening from without the Islamic world (Bohlman, 1993).

A second equally important concern was sonic orientalism, which has pressed various specific and local sonic/music practices into the service of capital, and the global music industry, by acting as sonic surrogates for commodified identity and authenticity. This is well discussed in Bohlman, who refers to musicology as a political act. So too potentially is composition.

Through an intensification of the negative aspect of the *sama'* polemic, *BGZ* contests both sonic orientalism and puritanical ideologies. The piece avoids presenting referential sound to signify exotic alterity, and trace is intervened into to present affectively ambivalent signals to the listener, it hovers somewhere between the beautiful, the anxious, the fearful and the disturbing, and in so doing hopes to present opacities in the listening stance.

In *BGZ,* trace operates both indexically and symbolically. Many are mimetically referential and there is an intended layer of symbolism. The *adhan* can be the orientalised sound *par excellence* in relation to the privileged Western symbolic system that Bohlman refers to. Its ubiquity within current mass media as bearer of 'the Islamic' cannot pass without comment, and so its inclusion points both West and to the East. Throughout *BGZ, adhan* is present mostly in transformed trace that hover on the edge of recognisability, usually masked or conjoined with other traces. This itself refers to its pervasiveness, and to its disciplining sonic presence in the MENASA. In *BGZ,* the *adhan* AOs are often intervened into, technologically effaced; mutated and transformed.

The key strategy was to excise trace, which is regarded as inadmissible in terms of the *sama'* polemic. The acoustic spaces of mosques and *zaouias* afforded interesting cases, because the reverberated tails carried the immediate after-effect of the (inadmissible) 'music'. I became intensely aware of the auditory disciplines associated with Islamic rhetorical practices. The onsets of words, the resumption, the pacing of time, rhythm and melisma became strangely present in their absences as I reduced the material into a set of adjacencies, gaps, throat clearings, breathe and reverb tails. The residual traces offered a starting point. The implications of the injunctions against music were traced – the hegemonic reach of the *sama'* polemic is investigated, and taken issue with.

The work has appeared in two fixed multi-channel forms. The submission includes the concert version, but a longer version was installed at the Leighton House Museum in London, the previous home of the eponymously named Victorian orientalist. This context provided a double specificity – contesting an Islamic soundscape in a place that exoticised Middle Eastern culture at the height of the British Empire. *BGZ* then operated as a disruptive agency[81], referring to an alterity, and engaged the context in which it was presented, not only raising questions for the listener, but taking a position on the matter.

5.3.2 Techne

The work is formed from fragments and longer sections derived from the digital manipulation of the field recordings. The editing process revealed interstitial trace, the residuum of the spaces – birds, resonance tails, breaths, overheard conversations, extraneous sounds floating into the space, sounds that were not designated as halal and part of the ritual. These stems were categorised into dominant classes: 'wind' derivatives, 'bird' derivatives, 'voice' derivatives, outside ambience, reverberant acoustic, traffic and so on. The large number necessitated a way of organising them.

Psysound 3[82] (in Matlab) implements psychoacoustical algorithms and I used it for frequency-time (ST) feature extraction, chiefly silence detection, loudness fluctuation, sharpness, roughness, pitch, time-averaged power spectrum, and some binaural attributes of auditory lateralisation and image width (Cabrera *et al.*, 2007). These graphs could be filtered

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[81] This was apparent from comments in the visitors' book. Some vehemently objected to the 'awful noise' that 'destroyed the beauty of the museum', while others suggested 'it activated the place', was 'powerfully affecting', and 'thought provoking'.

[82] This gave me a potential database of sounds. I intended to store them in a metadata searchable format, such that an algorithmic engine might control playback according to various criteria, for a self-assembling installation that would create non-identical iterations. However, due to new projects emerging and time constraints, I abandoned the attempt. In the light of my developing approach towards de-emphasising the listener-composer subject, I plan to return to it.

in Matlab, changing the degree of temporal resolution (and thus computational load when later used in Max/MSP).

The extracted lists were stored in text files, imported into Max/MSP[83] and used as 'sparse representations' to parametise a variety of synthesis patches, generating derivatives that shared some perceptual features with the original. I found that subtractive/FM resynthesis usefully generated synthetic sounds that were spectrally reduced.

This yielded a set of 'second generation synthetics'. I also processed the original, first generation stems using the gak~ genetic algorithm kit external for Max/MSP to yield lineages of related sounds. The initial stem underwent genetic transformation, and the resulting children selected by auditive introspection, which were further processed via the same patch to yield familial lineages. They became increasing opaque in their perceptual relation to their originating source (in Denis Smalley's terms yielding more remote degrees of surrogacy). Additional lineages were created using concatenative synthesis techniques.

Group lineages were transformed using a variety of techniques. In LiSa[84] stems from different familial lineages were placed at different points in the audio buffer, and their associated playback zones sent to different audio output channels (Waisvisz and Baldé, 2007). Algorithmic patterns and manual gestures were applied to these zones simultaneously performing parallel spatial and spectrotemporal processing (such as sweeping the start position, length of buffer, transpositions, various effects processing). This afforded a chimeric play with perceptual integration / desegregation across seven channels. At times the sounds are clearly in perceptually dissimilar streams, but may suddenly modulate and transit together (Bregman, 1990; Scheirer, 1996). The technique occurs throughout. In the Vienna

[83] The 'text' object allows lists of data to be stored. The 'coll' object allows for the indexed collection of n-dimensional data. The 'route' object sends data to a specific outlet based on the index of a list. This allows access for use by other synthesis patches. See: https://docs.cycling74.com/max5/refpages/max-ref/coll.html.

[84] LiSa (by STEIM) is a sound manipulation software designed for live sonic performance. Its functionality centres on an audio buffer that can be simultaneously accessed at different time points, manipulating multiple sound streams in parallel using automated pattern or sequencer controlled playback and/or live gestural input.

concert version, examples can be heard from 16:21 onwards through to around 17:04. Distinct bird and voice traces suddenly transit and terminate together, and rhythmic and spatial streams separate and coalesce. A further example occurs between 21:10–20.

Some stems were segmented into Rex files, and imported into sample-based synths manipulated in Ableton Live. This was used extensively for bird traces such that individual AO components could then be transformed and spatialised. Some additional ex nihilo synthetic components came from the Nord Lead 4 genetic algorithm patches, especially for slowly evolving sounds (Dahlsted, 2013). An example can be heard fading in at 7:06 as a spectrally shifting drone that continues throughout the section and fades around 9:00. This spectral grounding is removed prior to a deceptive and brief transition into a tranquil insectile night scene, disrupted by a sudden dog bark. This AO semantically indexes something angry, possibly mad and potentially threatening that must be calmed. Symbolically, the Arabic word for dog (*khelb*) is an insult. Obliquely, this conceptually prepares the ground for the first recognisable *adhan* at 9:49, itself a clear cultural reference that is beautifully rendered, intended to offer a contradictory aesthetic emotion.

The overall form was initiated by selecting continuous field recordings to use as temporal templates. Specific feature time positions were marked into the time line. Transformed files belonging to that particular lineage were selected and replaced the original sounds. For example, when listening to a field recording taken in the courtyard of a mosque in Mazzouga, Morocco, a group of birds descended just after Zuhr (noon prayer) and began an increasingly heated exchange lasting many minutes. These were substituted using bird derivatives taken from various LiSa, Ableton Live, Max/MSP processing and can be heard between 15:30–16:14.

5.3.3 Biopsychosocial reflections

While the resected stems carry no trace of 'music' (in the sama' polemical sense) the semantic cultural referents are clear, and many retained affects and ambiences. *Adhan* is an obvious index of the Islamic sonic-social context. Symbolically, birds are fundamental to Sufi cosmology as signifiers of the soul. Wind (*nafas*) conveys significations of breath, soul and the desert as a place of turbulence[85]. These AO signs help locate the traces in conceptual networks.

Various technological interventions are made into AOs. Artefacts in sound analysis techniques, constrained by CPU, contain a degree of error and are rarely precise[86]. They became a means to mutate and chimerically transit these signs, affording experimental and unforeseen outcomes. Each template trades frequency and time domain resolutions and potentially introduces mutations. These were applied to resynthesis, and the shaping of subsequent digital signal processing, adding entropy when artefacts were introduced into recursive processing. As well as generating new ST variations, when applied to recognisably referential sound, semantic mutation was also underway. They became translational mutations, inaccuracies in the transmission of the aesthetic code. Some had saliencies that I found interesting and selected, submitting them to further analysis and processing.

The movement between unprocessed field recording and their transformations allows culturally identifiable events to be retained. These potentially act as mnemonic anchors, providing explicitly referential marks. The interplay of familiarity and novelty led to my considerations of mnemonic systems and how memory becomes degraded and collapsed into overlaid composites, losing a clear sense of temporal order and specific context. Episodic trace is a malleable entity.

Mnemonic traces and their transformed descendants allow manipulation of time and space, both at the level of the AO and socioculturally. These traces bind salient perceptual cues and their visceral markers linking perception with emotion and context. Of importance here, is that the inscription of trace rests on a complex array of perceptions, emotional arousal and valence, semantic significance and embedded context. The memory recall (in

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[85] See for example Pâques (1978).

[86] For example, clutter in STFT analysis and other frequency – time resolution trade-offs are well described (Curtis Road, 1996: 561).

BGZ, the retrieval of the experience of place) relies on accessing cues that ramify through associative networks which cannot be suspensively bracketed out.

In *BGZ* traces and their descendants create a play with recognition, a sense of familiarity or strangeness, a sense of place or a trace of context. Time collapses into a composite accretion of experience in space. What is held in memory loses its linearity, and contributes to a collaged image. In *BGZ* fragments (lasting from grains down to 300ms, up to segments extended for many minutes) of the original recordings may recur, but do so within the changing context of other fragments and transformations. AOs may be heard, and reheard, both in their original versions, and by lingering resemblances retained through successive transformation. While they may be deformed, at times they retain sufficient source regularities as to be capable of activating memory networks – either because the listener has experienced them in the work, or they may have a familiarity with the sonic-social context from which the material derived.

❊

In the studio, I reflected on the ubiquitous presences of birds and the mythological status of bird-as-soul within Islamic culture. The title of *BGZ* was suggested by the poem *Birds Through a Ceiling of Alabaster* by the Abbasid poet al-Udhari (1976). The poet gazes up to the alabaster ceiling, seeing the shadows playing across the dome of the birds beyond in flight. These veiled entities put me in mind of Schaeffer's acousmatic reduction, the shadows on the walls of Thomas Metzinger's ego tunnel, and his birds appearing through the transparent window of consciousness.

5.4 Makharej

> […] in the emptiness, I disassembled a letter from one of the ancient alphabets, and I leaned on absence […] (Mahmoud Darwish, 2008)
>
> The Breath of the All-merciful: Just as the Arabic alphabet has twenty-eight letters through which the names of all things may be pronounced, so the cosmos has twenty-eight basic 'letters' which combine to produce all created things (Ibn al-Arabi, [circa 1230] 1989: 127).

Makharej (plural of makhraj) are the places from which the Arabic letters somatically emanate to form their 'correct' enunciation (see Figure 20). It is a live piece for Arabic vocal performer and electronics that investigates the sonic possibilities of the Arabic alphabet.

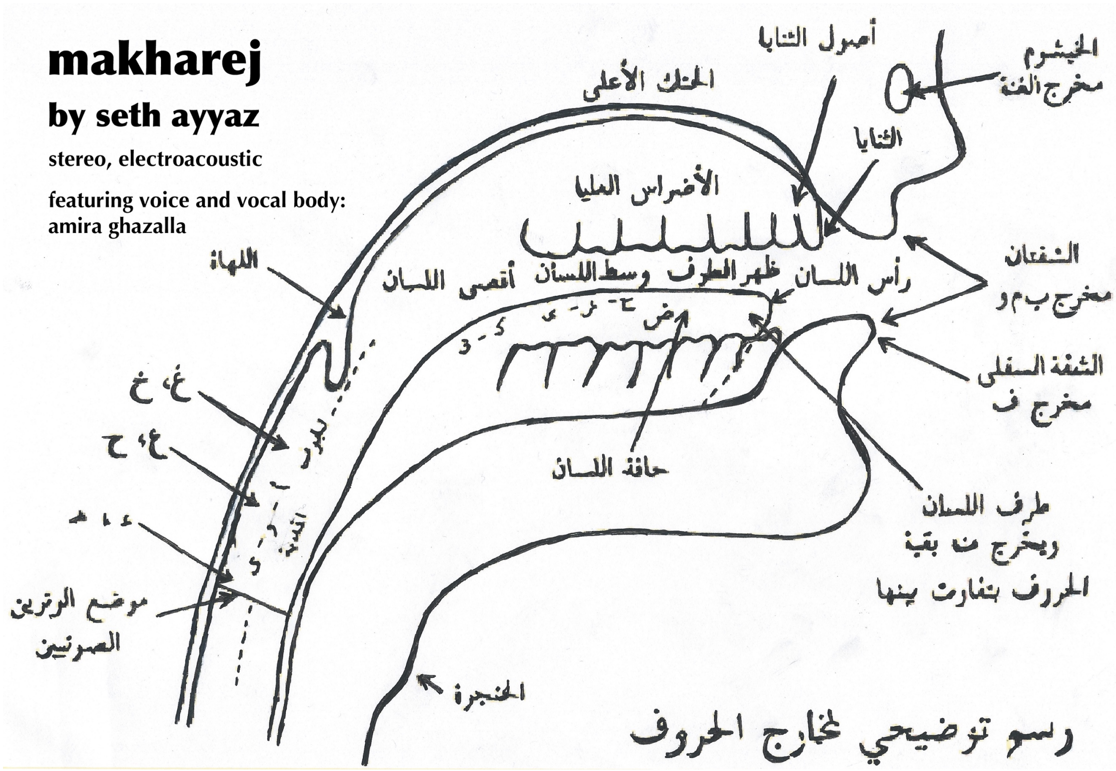

Figure 20: Publicity image for *Makharej*: places from which letters of the Arabic alphabet are articulated

We do not pronounce the *makhraj* but rather pronounce from it (as shown in Figure 20). It is closely linked to the traditions of *tajwid*[87] governing Qur'anic recitation. For a religious tradition rooted in aurality, preservation of the sonic letter has special emphasis. The title is also a colloquial play, meaning a denouement, to make a graceful exit from a difficult situation.

Makharej engages a plurality, in part inspired by European sound poets such as Antonin Artaud, Kurt Schwitters, Bob Cobbings and Henri Chopin. However, such sound-play takes on other signification engaging the associated ethico-aesthetic regimens. Transformations of

[87] See *Glossary*.

pronunciation potentially produce distortions and comments upon their semantic, linguistic, cultural and religious aspects.

At the time, I was thinking through alternatives to the Phenomenological ear presumed by acousmatic discourse, and compositionally wanted to articulate the two adjacent worlds of the correlative split. In the piece, one world is somatic and proximate to the voice as the symbol of self; the other is forever remote elemental anonymous and noumenal.

5.4.1 Assemblage

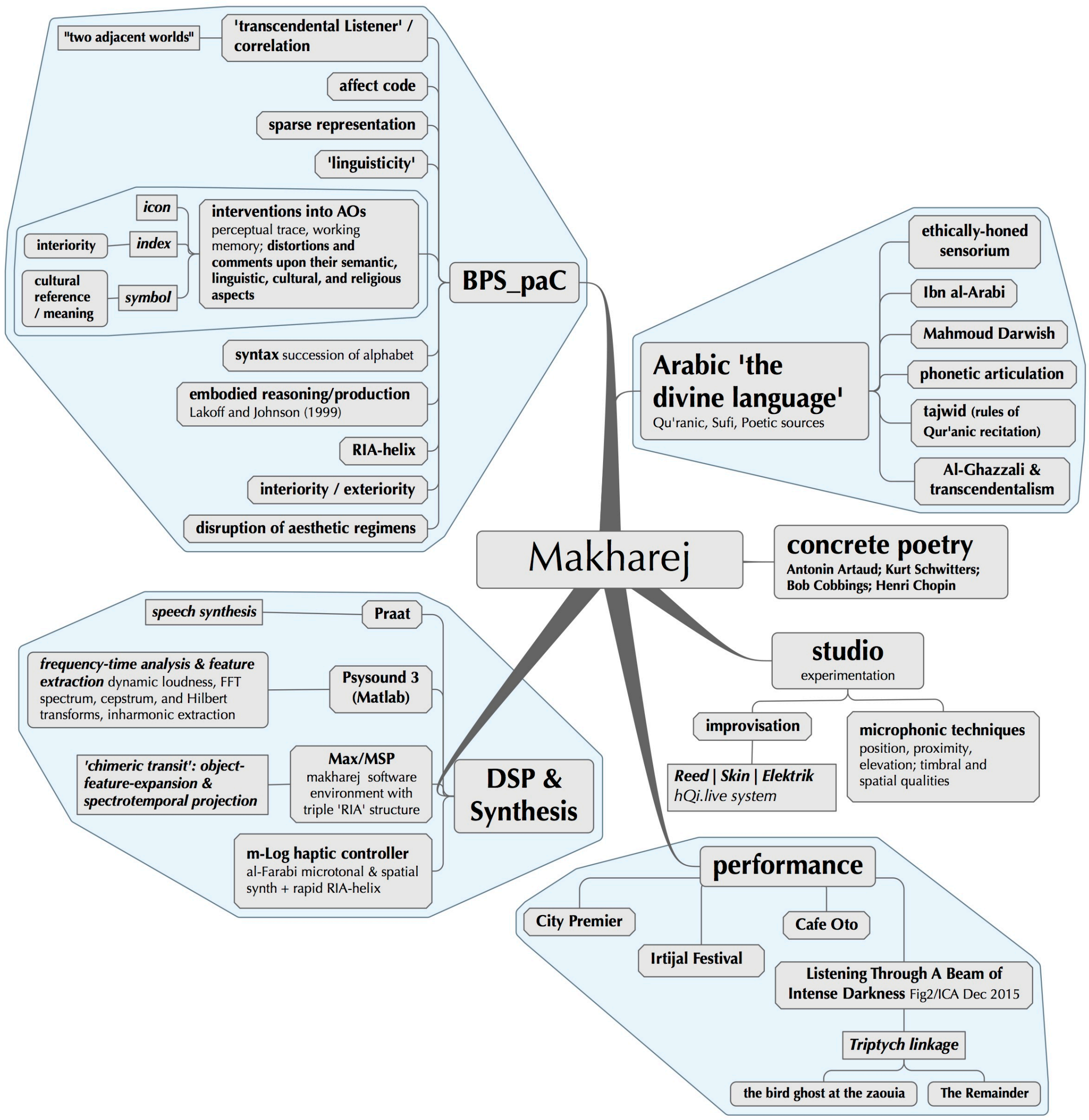

Figure 21: *Makharej* assemblage

Key elements of the *Makharej* assemblage are shown in Figure 21. This assemblage punctualized into two versions: initially a fixed work (submitted), it developed into a live version (submitted video). Although the performance requirements differ, I shall discuss the two together.

Each letter is pronounced in its exemplar correct form, and is accompanied by a derived letter-scene. The piece is through composed. Long-distance dependencies follow the conventional succession of the alphabet. Syntactical dependencies by perceptual trace operate locally in each letter-scene, but the listener will also hear longer-range similarities and dependencies between some letter scenes (for example *nuun* and *miim*).

The letter-scenes were generated using feature extraction (FE) on the vocal exemplars, either analysed as sound files in the studio using Praat and/or Psysound 3, or from live input using standard machine listening Max/MSP objects or externals. Similar to *BGZ,* FEs were mapped to parametise various response synths to create the accompanying scene, using elements of the centripetal ST structure, and a generate-and-test method to trial alternative possibilities.

I shall discuss several BPS_paC ideas in relation to the piece: assemblage and the sequence of compositional activity; signal processing modelled on the RIA-helix; two adjacent worlds; and, object feature-expansion and their projection (related to Box 2).

As a non-Arabic speaker, I attuned my ears to Egyptian taped sermons, and took Arabic language classes to reacquaint myself with the basics of the spoken and written language[88]. I collaborated with Amira Ghazalla, an actress originally from Cairo who researches body practices related to language production[89] and has a nuanced understanding of the *makharej*.

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[88] In common with many non-Arab Muslims, I learnt Surah and recitations by rote without much understanding.

[89] Amira was involved with the experimental Berlin film and theatre world of the 1970s/80s.

We discussed the significances of the letters in poetry, Qur'an and Sufi writings[90] and the ethico-aesthetic implications of 'deforming' the letters sonically, which (for some) equates to challenging orthodoxies, and also to laying a personal claim to the 'divine' language.

From a BPS_paC perspective I wanted to investigate the physical production of the spoken letters, the role of the body in extending the sounds, the kinds of psychological charge that could be achieved, the social implications or meanings that could be activated, and the idea of the transcendental subject.

Once the scope began to clarify, we undertook extensive studio-based investigations, making detailed recordings of each of the letter categories. Four channel recordings were made using different microphones[91], experimenting with positions, proximity and elevation to achieve differing timbral and spatial qualities. These microphonic techniques are well known in EAM, exploiting amplification and position to create variable degrees of spatial proximity to the voice, from close up capturing intimate corporeal aspects of trace (breath, 'wetness' in vocal tract, hearing the machinations of the vocal apparatus itself, drawing attention to the voices physicality[92]) through to more distant trace (focused more on the 'where' attributes). Some of these spatial versions of the voice were used (in transformed variants) in the piece[93]. Analyses used mono files.

We worked extensively with different intensities, inflections and affective connotations. The recordings were discussed to select an exemplar for each letter. A significant number of variations fell between categories and were discarded. There are many complex sounds such

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[90] We eventually chose a Darwish poem which is included in *Appendix A1:03* and texts from Ibn al-Arabi, both quoted above.

[91] AKG C1000S, Yamaha SM58, Studio Projects C3, Oktava Mk 012, DPA d:facto II vocal, and Neumann TLM 103 Studioset.

[92] An example is clearly evident from 1:37 when the voice enters as breath, through to the pronunciation of the alif. It is in counter point with overt noise elements, which are generated from these same breath sounds, giving a possible clue (in C-E stance) to the two worlds of the piece.

[93] Examples are evident in the taa' / th!aa' section between 4:21 and 5:55 where variations occupy differing proximity and apparent acoustic spaces.

as *laam* – tongue, teeth, sinuses; *miim* – closed mouth; *kha* – soft palate, in the throat; *H'aa* – abdominal. The somatic production fell into three broad groupings: elongated (along the breath, continuous, resonant); with air; plosive (short, iterative).

5.4.2 Triple layer processing: reception, interpretation, action

The three main layers of the *Makharej* Max/MSP environment (Figures 22, 25 and 26) are modelled on the RIA-helix: reception (input or affector layer), interpretation (mapping, including gestural control) and action (response synths [Sr] or effector layer). This was used to compose electroacoustic parts and was later adapted for live performance.

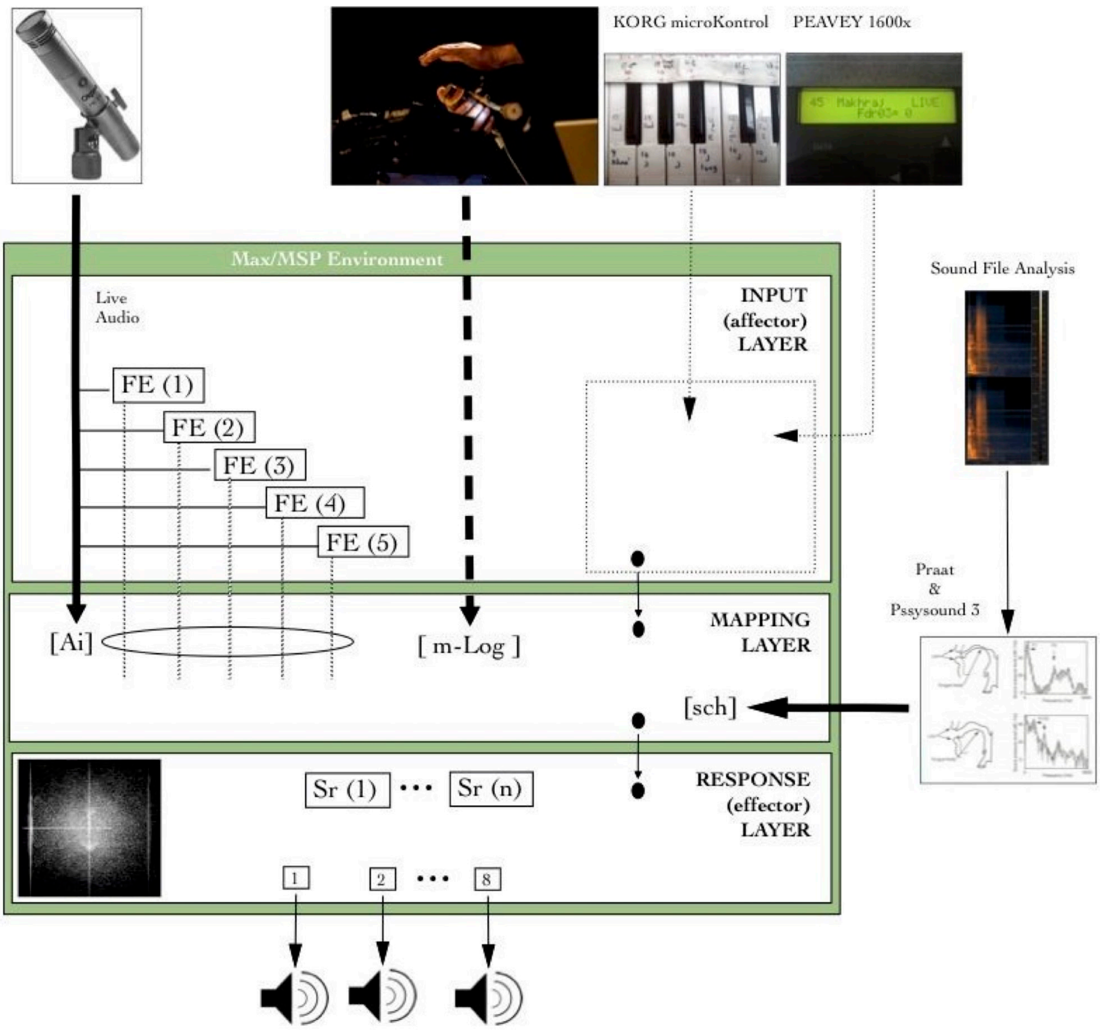

Figure 22: Schematic of signal flow in *Makharej*

From top left, microphone input, the *m-Log* OSC controller, other MIDI controllers. These feed the input or reception/affector software layer, which contained analysis patches (FE) extracting features from the audio (either live [Ai] or as sound files). The exemplar audio files were analysed externally and their data (sound file analysis), [sch] as text files is read in the mapping/interpretation layer. This sends control signal to different synthesisers in the response/effector layer, generating audio outputs.

Figure 23: *Makharej* suite of feature-extraction Max/MSP patches

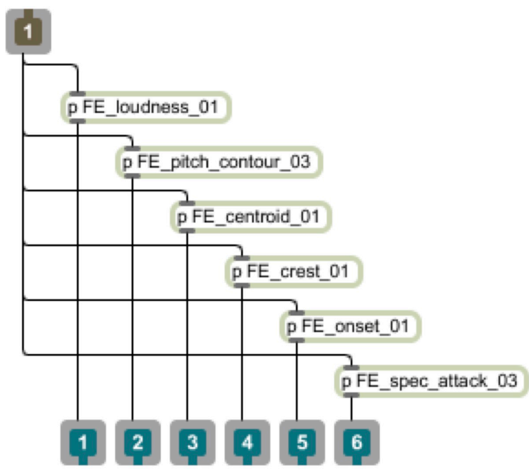

Figure 24: Example feature-extraction module: FE-1

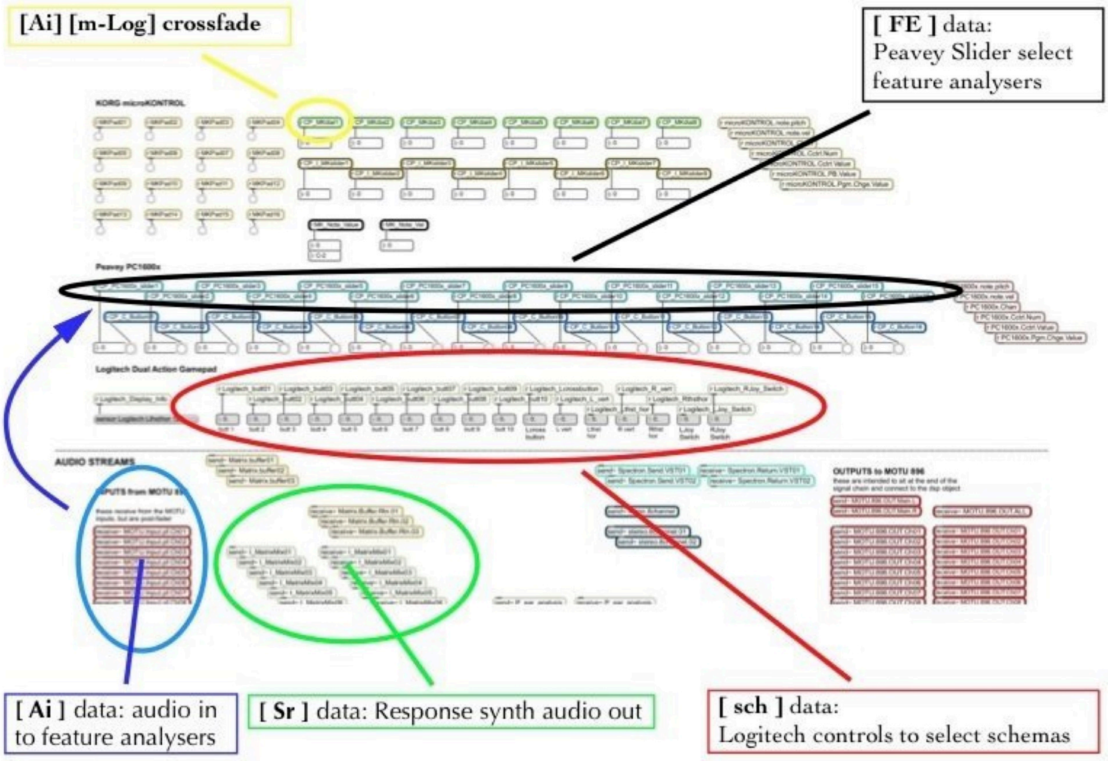

Figure 25: *Makharej*: data and audio streams in Max/MSP

The data streams at the top include control feeds from Korg microKontrol, Peavey 1600x, and/or Logitech Game Controller. The Peavey sliders mapped to the outputs of various feature extraction (FE) objects e.g. slider 1 sent the output from an onset analyser. Each control turned on its respective FE object, and the remaining continuous control messages were used to set thresholds above which the data would pass. The objects in the bottom middle were audio feeds from the various response synthesisers that could be selected and mixed to the main outputs on the sound card.

Figure 23 shows a palette window used to select individual FE patches. They are organised into primary perceptual groupings of intensity, pitch, duration, timbre. Space was not addressed. The second column shows perceptual dimensions (inspired by the K-matrix and Daniel Levitin, 2006). The next column accesses the patches themselves, with a brief description of their key functions. The 'other FEs' (bottom) include techniques such as linear predictive coding, sensory dissonance and tracking phase vocoder. These were combined into modules (labelled FE-1, FE-2 and so on in Figure 22, and an example is shown in Figure 24).

The [Ai], [*m-Log* / other controller] and [sch] reception streams could be kept separate or converged to control the response synths (shown as [Sr] 1 to n). This allowed some

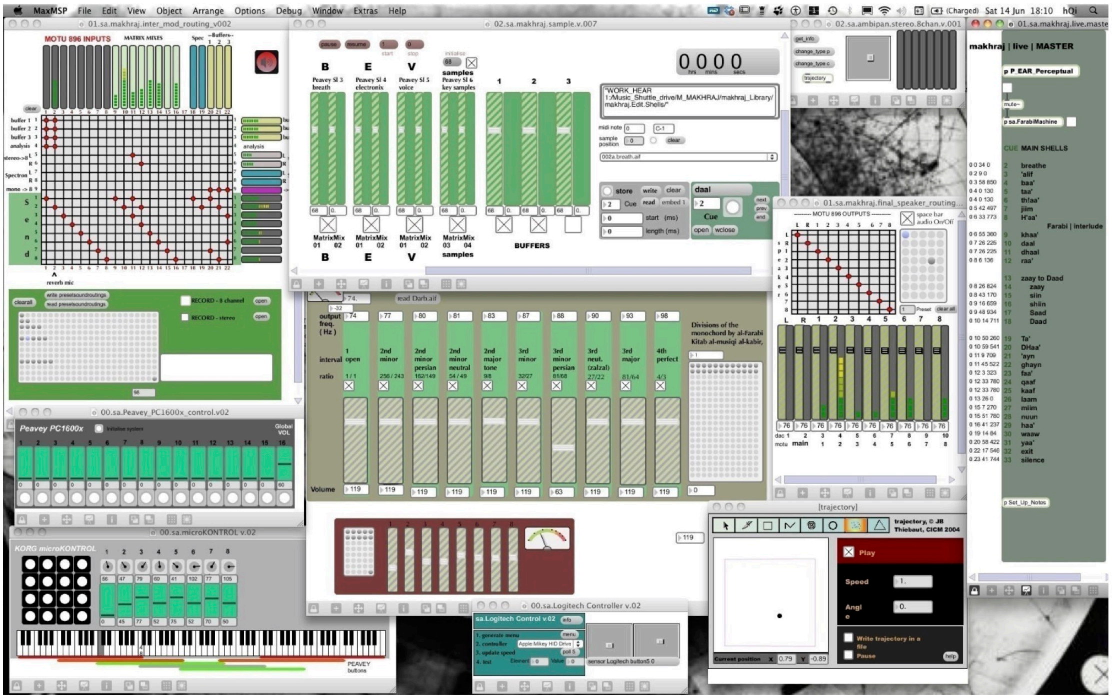

Figure 26: The main Max/MSP environment for *Makharej*

Letter-scenes are on the right, the mapping layer is top left and the al-Farabi spatial synth is in the centre.

synths to track the voice independently of my gestural actions with the m-Log, which could be controlling other [Sr]s, thus keeping the two worlds apart or merging them to varying degrees depending on a toggle switch on the m-Log. The degree of merging was controlled via MIDI (Figure 22).

AO letter exemplars were studio analysed using Praat and Psysound 3 (MATLAB) to generate text files ('schemas' [sch]) used to drive synthesis[94] (Boersma and Weenink, 2003). I found Psysound the most productive of the two software environments, focusing on dynamic loudness, FFT spectrum, cepstrum, and Hilbert transforms[95].

[94] The [sch] files acted as automation curves for the Sr response synths, exploiting OOP polymorphism so that a message such as \freq would be interpreted by differing synths according to their local capacities.

[95] The cepstrum shows periodicities in the harmonic structure; the Hilbert transform is a simple way of extracting the envelope of a signal, and outputs instantaneous loudness level, frequency and phase.

The [sch] files had three degrees of temporal resolution[96] (high, medium or low), giving increasingly sparse representations of the original features. These generated break-point values against time to preset automation envelopes for the [Sr] synths. Some [Sr]s also read them as look-up tables to generate fixed-waveform functions. I experimented with using these [sch] files as transfer functions in the mapping layer to relate inputs from [Ai] or [m-Log] to scale and transform the [Sr] response. However, this proved unsuccessful, as their effects were not transparent in practice. Instead simpler linear and exponential cross-fade functions proved more useful.

Broadly, I could move between three poles: real-time [Ai], [sch] data or manual control of output synths. The first proved unstable, adding time delays and computational load that while tolerable in the studio was too risky in live performance. The [sch] files, variably merged with *m-Log* (and other control streams) linked to a variety of synths proved more interesting, with [sch] giving a general structure to the scene, intuitively intervened into with manual gestures.

The effector layer contained the variety of responding Max/MSP and Reaktor [Sr] synths that produced sound. I trialled many synths to find the right palette, eventually settling on sparse, noisy, granular, sonal qualities that worked well with the inputs, and contrasted with my al-Farabi microtonal additive synth. I wanted to invoke an elemental universe that was clearly distinct from the vocal components (although related to them), eventually settling primarily on additive, subtractive, FM, granulation, and stochastic noise-based processes.

Keyboard note allocations selected studio composed letter-scenes, processing networks (from each of the three layers) dedicated to each letter-scene successively (seen as Arabic script on the keys in Figure 22). Each key called a group of presets for: vocal/audio input live buffers and analysis [Ai]; feature-extractors [FE]; selection of response synths [Sr]; and

[96] The initial analysis was at 44.1 KHz resolution. In Psysound/MATLAB, these can be easily represented as graph plots, and time points filtered to give coarser detail, picking out the most prominent features.

response synths were prepared with settings chosen to work well in the studio with the [sch]. Once a letter network was activated, the 4x4 pressure grids on the Korg accessed studio prepared letter variants and control envelopes to transform them live.

5.4.3 Two adjacent worlds

Two streams of transformation are used in *Makharej* – the embodied subject voice world and the disincarnate noumenal cosmos. The voice is treated subtly, with changes intended still to be heard as voice, but extending beyond biological parameters[97]. The articulation of vocal sounds and a sense of embodiment are inextricably linked in our listening.

In the live situation, the processing was computationally expensive, so some electroacoustic components were pre-prepared to obtain a degree of detail that is illusive in real-time, and to maintain the stability of the assemblage. These were used alongside real-time processing and spatialisation in the live context.

In the studio, the articulations were deconstructed in a variety of ways at the sub-phonemic level. Montage techniques spliced recordings of the same letter offering different microphone colouration and distance from source. Similarly, outputs of the [Sr]s were spliced together, using differing onset and continuant components. Phenomenally the 'same' voice could speak at times simultaneously, from different locations and with chimeric transits, suggesting impossible embodiments.

The second stream of processing is overtly electronic, providing the elemental and sparse noise based accompaniment tailored to each letter-scene.

97 For example, manipulations of formants and perceived vocal tract size to androgynise the voice (heard during the *miim*); the insertion of band-passed noise and sine tones into the vocal spectral envelope (*waaw*).

5.4.4 From alif to alif-baa: auditory object analysis and feature projection

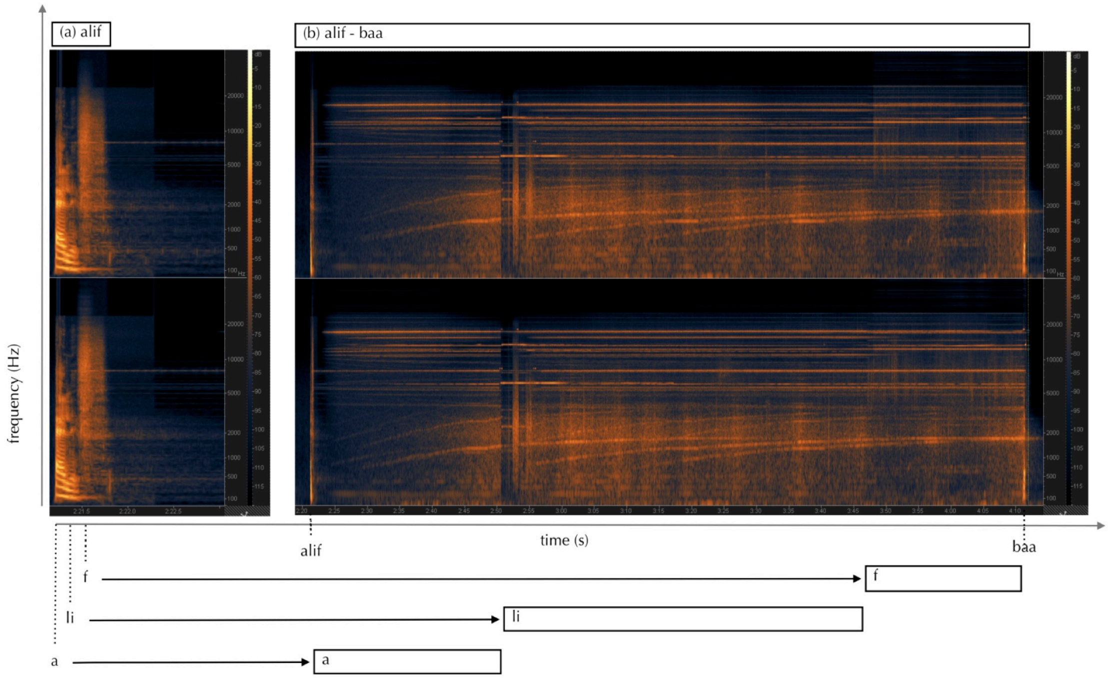

Figure 27: Alif and alif-baa AOs in *Makharej*

The figure shows the projection of spectrotemporal structure contributing to the *alif-baa*' letter-scene. The y axis plots frequency (Hertz), and the x-axis time (mins: secs). All time values are at 0.005 s resolution. The image is taken with iZotope RX software.

In Chapter 3 I discussed AO formation. Grouping by simultaneity cues occurs within 80 ms following stimulus presentation and relies on harmonic regularities in the acoustic signal (Bregman, 1990; Winkler, Denham and Nelken, 2009). The *alif* is quick. Although not easily discernible in Figure 27, the harmonic structure is evident within 40 milliseconds of the 'a-' onset; hence we hear it as a unified object. Projected features from *alif*, to beyond the temporal range of WM, the *alif-baa* scene is not heard as a unitary object. While the formal relation is there, as Schaeffer might object, it is not immediately audible. My intention was to experiment with such relations, and to open out initially inaudible details, projecting, scaling and amplifying letter elements to structure their accompanying scenes.

Figure 27 gives an example of this AO analysis and feature projection technique[98]. This develops the technique used in *BGZ*. The merging of input-features with gestural control was later used (with refinements) in *R | S | E*, and the *bQi.live* system on the *Conspirators of Pleasure* tour (discussed in the next chapter).

I shall discuss the *alif* letter-object to *alif-baa* letter-scene transformation in some detail to explicate my method. Two frequency-time plots from the *alif* and *alif-baa* section are shown. At 2:22 in the fixed version, *alif*, the point of origination[99] as the first letter of the alphabet, is pronounced, setting *alif-baa* into motion. The two plots, at different time scales show (a) *alif* and (b) the *alif-baa* scene. The former has a duration of approximately 0.80 seconds, and the latter 112 seconds, a temporal expansion by a factor of 137.475. Plot (a) is subsumed into (b), *alif* now appearing as a vertical orange line. The AO 'edges' of the three formants a-, -li-, and -f are visible in (a) (Kubovy and Van Valkenburg, 2001). These were temporally expanded to guide the three sections to the *alif-baa* scene. In (a) the harmonic formant structure is evident. In (b) these harmonics are spectrally inverted, their relations distorted, and considerably time dilated. Additional static frequency components have been added by the al-Farabi synth, which has also frozen, inverted and processed inharmonic components of the -f formant. These can be seen persisting across the much of the scene above 5 KHz.

Elements from the *alif* analysis [sch] file (generated by Psysound) are shown in Figure 28 (a) and (c) and provided a starting point for the features of the letter-scene (b and d). The latter was embellished using a variety of synthesis techniques.

[98] This intervention into and remodeling of AOs derives from the discussion in *Box 2* of Chapter 3.

[99] Prior to this, relatively unformed noise textures have approached and receded, and the listener has moved through breath, denoting a possible living presence. Breath is a highly associated symbolic trace connected to life and nafas (Arabic: the soul). The opening also contains barely audible subvocal prayer and magical incantations, as well as breath extensions that are physiologically impossible (exhalations followed by exhalations and inhalations by inhalations). In X-stance, it is possible that an attuned listener may implicitly and affectively register clues about concerns of the piece – frail embodiment in an indifferent elemental universe.

(a) 'alif' object (vocalisation)

Temporal values of alif object-analysis

	a -	- li -	- f	total dur
onset time (min:sec)	02:21.200	02:21.315	02:21.460	**00:00.800**
duration (min:sec)	00:00.115	00:00.145	00:00.540	
relative ratio	1.00	1.26	4.70	

Mapping from (a) to (b) by y = f(x)

f: value	137.475

(b) 'alif-baa' (extended section)

	a -	- li -	- f	baa	total dur
onset time (projected)	02:21.200	02:37.010	02:56.943	04:11.180	**01:50.0**
duration (projected)	00:15.810	00:19.934	01:14.236		01:49.980
relative ratio (projected)	1.00	1.26	4.70		
Temporal values scale-up from alif object-analysis					
onset time (actual)	02:21.200	02:51.000	03:48.000		
onset variance	00:00.000	-00:13.990	-00:51.057		
duration (actual)	00:29.800	00:57.000	00:23.180		
duration variance	-00:13.990	-00:37.066	00:51.056		
relative ratio (actual)	1.00	1.91	0.78		

(c) 'alif' object (vocalisation)

Spectral values of alif object-analysis

	frequency Hz
f (0)	140
f (1)	280
f (2)	420
f (3)	560
f (4)	700
f (5)	840

(d) 'alif-baa' (extended section)

Dominant spectral values of alif-bar scene analysis

	frequency Hz
	17600
	17100
	15600
	12350
	11025
7850-8100	
	6075
	5675
1630	
	1340

Figure 28: Auditory object feature projection in the alif-baa section in *Makharej*

The top section (a) concerns plot (a) of Figure 27 – the vocal pronunciation of the *alif*. The onset time, and duration of each of the three formants a-, -li-, and -f are given. The temporal ratios of these three components are given, relative to the shortest component a-. The lower section (b) shows the temporal expansion of these components by a factor of 137.475, which partially structures the *alif-baa* section, shown in Figure 27 (b).

Key harmonic and temporal values are shown in Figure 28. Table (a) shows [sch] data for alif, giving the onsets, durations, and relative durations (ratios with respect to the shortest component a-: 1.00:1.26:4.70). A simple y = f(x) mapping of letter-object to letter-scene provided a starting point, with f = 137.475, an arbitrarily large expansion factor chosen by random number generator to ensure the *alif-baa* would exceed WM limits. If the [sch] data was simply read as automation data to drive the relevant [Sr] synths, we should expect onsets at 2:21, 2:37 and 2:56 with durations of 15.8, 19.93 and 1:14.24. However, the actual values of *alif-baa* are onsets at 2:21, 2:51[100] and 3:48 with durations of 29.8, 57.0 and 23.18 seconds. The table shows the variance between the projected and actually observed values. This variance is accounted for by deviation from the [sch] automation due to manual control interventions merged in the mapping layer from *m-Log* and other gestural inputs.

As well as temporal projections, spectral cues were also used. In Figure 27 (a) the harmonic structure, (especially of the a-), has clear ST regularities. Figure 28 (c) and (d) show the analysed frequency values. The former shows the integer relations of the first five harmonics of a-, with f(0) at 140 Hz. 28(d) shows the more complex *alif-baa* spectrum. There are five distinct static high-frequency components in the 11025 to 17600 Hertz range which are dominant in the analysis, although of variable intensity. These form the 'unnatural', synthetic effect of the sound in perception and exert visceral effects. Lower down the spectrum (Figure 27 (b) and Figure 28 (d)) bands of ascending glissandi starting from 730 Hz converge on 1630 Hz. The onset times at 2:21, 2:37 and 2:56 are expected by [sch] projection from the *alif* object-analysis. These onsets derived from the a-, are not perceptually prominent, and their direction of glissandi invert the original. The complex spectrum results from a combination of the [Sr] synth outputs (GRM Tools Spectral Freeze, FM and additive synthesis). Narrow time windowed, pulsing noise derives from the intrinsic activity of the *m-Log* circuitry left unsmoothed. There is broadband noise, most marked between 500–3000 Hz which is derived from the -f generated by mapping to the Q and centre frequency of an equalized [Sr] noise generator.

This example is typical of the approach. ST features are extracted from exemplars, and used as guiding [sch] automation curves to project a potential structure into the corresponding letter-scene. This is intervened into (through experimentation in the studio,

[100] This transition into the -li- part of the scene is marked perceptually by a salient high-frequency crackling gesture. The same [Sr] synth is heard in various places later on, denoting similar projected formant transitions.

and to a lesser extent in real time) through the listening-composing RIA-modelling guided intuitively by PSM introspection (by myself and Amira) to embellish and shape the scene. Each letter has a distinct affect and interiority – for example the *laam* scene (13:38–16:12) conveys a certain stridence that has to be 'withstood'; its synthetic spectrum that emphasis high-frequency partials can only be tolerated for a certain time. The following *miim* (15:18–16:00) warmly releases the tension along the breath. The *H'aa* (6:11–6:38) is ambivalent and androgynous (because of treatments of the vocal formants), whereas the *waaw* (19:33–around 20:53) has a descending, dissipative increasingly sparse affect code as the work draws to a close.

5.4.5 Biopsychosocial reflections on Makharej

The AO-analysis/projection technique computationally engaged trace as a material ST exteriority, while the compositional interventions were guided by interiority considerations. I was struck by Amira spontaneously inhabiting and somatically locating the letters as person-like, perhaps due to her theatre background. Each had an associated intentional-motivational state. *Alif* is declarative, gathering assurance as the scene develops, the *laam* is strident, the *miim* with its resonant hum is thoughtful and warm. Consequently, each letter-scene formed initially through nonhuman digital sparse-feature representations, was investigated by an associated affect-code linked to felt-sensations, enhanced by enaction with the *m-Log* (symmetric X-stance)[101] and imaginative interiorities (C-I stance).

I suggest that the piece illustrates electroacoustic technique as epistemic practice in two broad ways. Firstly, in terms of techne, like microphonic techniques (such as those used in the initial recording stage), computational analysis reveals trace features unavailable to introspective awareness, which can be projected and transformed spectrally and temporally

[101] See Section 3.4.1 Music Semantics.

(including spatially). However, rather than sample-based DSP, this approach allows features to be applied heterogeneously across parallel synthetic processes. In the case of *alif-baa* this developed complex spectra to create the denatured anonymous elemental world, which, considered from a stance of interiority, is compelling and affectively charged. Secondly, electroacoustic techniques operate as a technosocial means to intervene into and contest the aesthetic regimens associated with the 'divine' Arabic language at the semantic conceptual level. Their symbolic and wider cultural signification is at stake and critically engaged.

The assemblage successfully combines asymmetric, reflective RIA modelling in the studio, with a more immediate real-time and symmetrical helix through reflexively embodied improvisatory presence. From my vertex, the haptic agility of the m- Log was vital to achieving the affective coding. There are extended sections without perceptually appreciable voice in which the [Sr]s are largely automated, during which I was freed to work expressively with the *m-Log* and al-Farabi synth. These aspects are heard throughout as glissando contours, very low-frequency presences and pulses, gestural discontinuities and chimeric ruptures, and clustering frequencies creating sensory dissonances[102] intended to promote visceral trace and enhance the affectivity of the work.

The *m-Log* afforded a rapid RIA helix giving the necessary degree of embodied dexterity that could meet the flexibility and responsiveness of the voice. The rapid prototyping of [Sr] synthesis spaces allowed alternatives to be quickly generated and perceptually tested, allowing an intuitive navigation through a transparent sense of symmetric haptic relation with the sound, freed from the cognitive load that often accompanies computer performance and negotiation with the opacities of the laptop GUI[103]. The three-layer structure was an

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[102] Harmonics placed within ERB-bands create basilar interference patterns (sensory dissonance) intended to draw listener introspection towards reflective awareness of a certain 'wrongness'. Examples can be heard in the *taa' / th!aa'* section prominently around 5:18; and in *siin* at around 9:11.

[103] Much as in the window of consciousness discussed in Chapter 4, in real-time performance it is advantageous to 'hear through' the processing and not be cognitively encumbered with low-level details,

attempt to model the RIA helix, albeit rather crudely, in order to realise the conceptual aims of exploring a culturally resonant issue.

The two worlds of course map onto the transcendental subject and noumenal object discussion of Chapter 2. While the two worlds appear starkly divided as embodied and disincarnate/elemental respectively, this is only so in appearance. The apparent embodiment is heavily electroacoustically mediated and processed. Even when apparently solo, the subject-voice might sound simultaneously with differing AO 'where' characteristics and locations (exploited in the live 8-channel version), and extend beyond physiological capabilities suggesting impossible embodiments. Auditory object feature projection attempts to investigate the material realm, decentring the supposed limits of phenomenality, crossing the correlational void between listener and acoustic event.

5.5 The Remainder

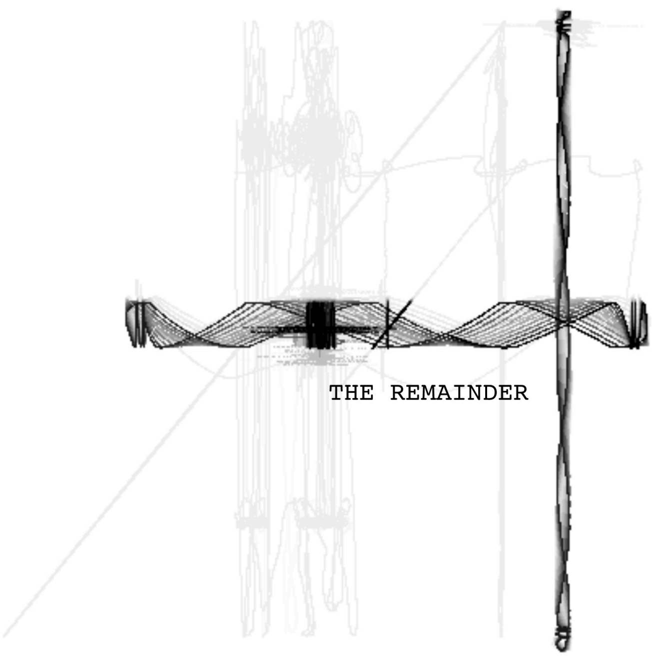

Figure 29: *The Remainder* publicity image

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such that the performance ecology gives a haptic sense of 'touching' the resulting sound, affording a tight perception-action coupling, as was discussed with respect to the perceptual domain of the K-matrix (Section 3.3.1).

5.5.1 Assemblage

> Allah's remainder (is) best for you if you were believing, and I am not with a protector/observer on you (Qur'an 11: 86).

But who is this Allah, who leaves behind a remainder? Is he other than the Allah, the indivisible One of 'La Ilaha Illa Allah'? Surely, there can never be any remainder for Him?

The assemblage for this piece is shown in Figure 30. It shows the main components brought into coherence in this fixed multi-channel work. Originating in Islamic mathematics and related debates

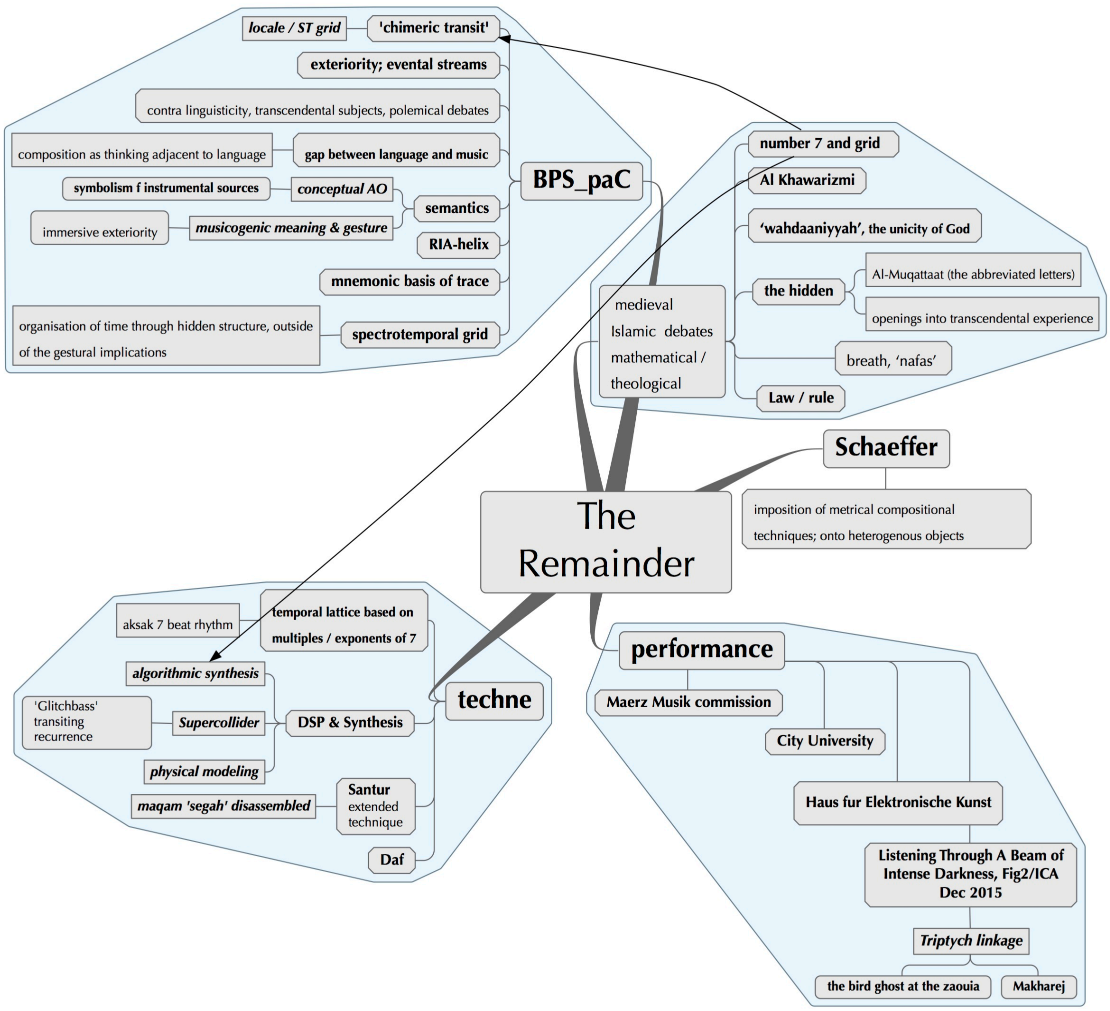

Figure 30: Key elements of *The Remainder* assemblage

between schools of Sharia, 'the remainder' is the number left over after all the operations of division have been completed; it is the smallest of the divisor, dividend and quotient and cannot be divided further. This remainder is contentious and threatens the *wahdaaniyya* (the

Unicity of God). Since there is only one substance, one God, nothing may remain. For the *Shiah*, that which remains points to something hidden, unrevealed.

Within Qur'an are combinations of letters (such as *alif-laam-miim, ya-seen, H'aa-miim*) that appear alone without comment or context. These remainders stand apart within the text. Known as *Al Muqattaat* (the abbreviated letters) they are sometimes referred to as 'the keys' and have been the focus of debate and mystical interpretation, taken as openings into transcendental experience (Reynolds, 2007).

The conceptual origins of *The Remainder* (2013) converge two unlikely roots: Pierre Schaeffer's early problem trying to fit concrete sounds into metrical grids, and theological debates concerning 'the hidden' in early Islamic mathematics and algorithmic theory[104]. Number and 'the keys' are taken as elements that point to an exit from, and remain outside of language. Towards the beginning of Pierre Schaeffer's *A la recherche d'une musique concrète* (2012/1952), he laments the lack of success in imposing metrical[105] techniques onto concrete materials. These sounds culled from the world did not fit into the traditions of scale and rhythmic bars. This led to a rejection of the grid to which time and pitch is habitually quantized.

Reflecting on his dispute with Xenakis, I wanted to approach the organisation of time and material using a hidden structure operating outside of the gestural implications perceptually inherent at the level of AOs. The sonic surface of *The Remainder* is a projection from an underlying mathematical exponential grid structure based on 7. Using trace such as breath, santur, daf and non-standard synthesis techniques, the structure simultaneously generates and is obscured by the sonic surface as objects form, fuse and transit. Working with Supercollider, the piece uses algorithmic techniques to drive synthetic processes that transform and shroud AOs.

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[104] The English word algorithm derives from the name of the eighth century mathematician Al Khwarizmi (Mastin 2010).

[105] The 'bound cells' of Negarastani's snakes and ladders board in Section 4.1.

This work forms the final part of the *On the Admissibility* triptych; it is what is left over, it implies a third point, maybe a triangulation that exceeds binary (correlative) thinking. *The Remainder* is a fixed 8-channel work commissioned for the Maerz Musik Festival, Haus der Berliner Festspiele, 2013. Paralleling the discussions of Part 1, it moves towards organised evental flows, and away from linguisticity, transcendental subjects and polemical cultural debates.

⁂

In Chapter 3 I discussed memory as the basis of trace. We infer alternative possible 'temporal grids' – reference time scales consisting of isochronic intervals – against which rhythmical pattern perceptions operate to produce the most economic mnemonically chunkable representation (Povel, 1984). I took this as a cue to experiment with this inferred ST matrix. The surface of the work is projected from a matrix that structures the division of time, frequency and other synthesis parameters[106] according to exponents or multiples of the number seven. The resolution of the matrix reduces over successive sections down to the final daf drum stroke[107]. These sections were overlaid in the studio with daf and santur which I performed with extended techniques, as well as al-Farabi gestures.

The Remainder begins with highly spatialised granular textures derived from temporal divisions of 7^7 (823543), the pulses and wavelets are so fine as to exceed our capacities to perceive individual events. They merge with breath (nafas) that might symbolise the originating impulse to life. Each of the sections takes from a reducing power of seven, parametising the algorithmic flows, so moving to 7^6 and so on, down to an explicit statement

[106] I will discuss one of the key synthesis algorithms below, but the set also included a Supercollider version of the al-Farabi synth. This generated much of the higher intensity glitchy bass rhythms heard prominently between 1:52 and 4:21. Like *Makharej*, its algorithmic automation (derived from the underlying matrix), was merged with *m-Log* gestural control in the studio.

[107] While seven sections were composed according to this matrix, in the final mix they overlap and are not of equivalent durations. They are approximately as follows: 1 (0:00–1:15); 2 (1:15–4:19); 3 (4:19–6:34); 4 (6:28–9:26); 5 (9:15–10:57); and 7 (10:46–12:01).

of the seven beat (7^1) *aksak* dance rhythm estranged from the body, and then to a unity (7^0) as an indivisible daf strike at the end.

The daf is an instrument loaded with martial and religious (Sufi) symbolism. The Iranian santur is also a culturally symbolically charged instrument, related to the Arabic *qanun* (meaning rule, law, norm, or principle). It was performed with extended techniques and 'enhanced' through detuning the *segah maqam* with 'unnatural' harmonics derived from divisions/multiples of *7*.

5.5.2 Streaming evental flows

In Chapter 2, I discussed predictive auditory objects and memory systems. Transformations may preserve key perceptual invariances while trace transits to new configurations; the invariants preserved provide a perceptual thread heard as recurrence and also variation. This approach is taken to the artificial synthesis of AOs in *The Remainder.*

A number of synthetic structures recur in each of the sections. I shall discuss one key example – the \Glitchbass synthesiser. It is heard in every section with matrix derived parametric changes that perceptually underpin the differences between sections. \Glitchbass is rather simple and conforms to a source, filter, effect model. The source (\grainmaker synth) is an 8-channel granulator that passes through either a low pass, bandpass or high pass filter (\filter), and into a reverberation effect (\fxreverb). The source creates synthetic waveforms based on sine oscillators, whose durations are related to the frequency of triggering. Individual grain triggering also controls the spatial location of the grains in an 8-channel field. The key variable that controls the source is '\rate'. The outputs are spectrally filtered with the cut-off frequency being controlled by a '\freq' argument, which goes to a simple reverberation controlled by '\room size' and the devisor, '\div' that chiefly controls the amplitude of the output.

Using multiples and exponents of the integer *7*, \rate, \freq and \room size are interrelated. I auditioned a large number of variations of grain size, spectral filtering, and perceived acoustic space (room size). The result was a certain perceptual consistency, but with a wide range of variations. In the opening section \Glitchbass generates very small grain sizes yielding highly spatialised swirling high-frequency cloud-like timbres[108]. In each of the seven sections of the piece, the same synthesiser (amongst others) is deployed using different parameters derived from exponents of 7.

At 4:22 \Glitchbass creates a background swirling bass context, alongside the higher frequency cloud textures. At 6:10, as the foreground figures recede, it bridges into the next section, where at 6:41 it re-enters (with different parameterisation) partially masked by the wooden santur body impact gestures. At around 8:36 the perceptually fused bass textures segregate into explicit audible rhythmic trace, to appear as a slowing figure halting at 8:50. By 8:55 (with a different set of 7s) \Glitchbass generates the rolling rapid rhythm. It is reparametrized from 9:21, hovering on the temporal boundary between fused timbral texture and individual rhythmic event, as the hammered santur gestures enter. At 11:52 it provides a pointillist outline of a seven-beat rhythm anticipating the daf sounds at around 12:02.

\Glitchbass is a mathematical graph function that algorithmically diagrams relations between input arguments and output trace, demonstrating an object that maintains an organising structure (outside of what is heard) which yields traces that are perceptually dissimilar. Its high-frequency cloud incarnation at the opening is very dissimilar to the later bass rhythmic incarnations. It also yields traces that appear perceptually as steady transits, as key perceptual invariants persist to create a chimeric lineage.

5.5.3 Biopsychosocial reflections

In its reception at Maerz Musik, listeners reported a hypnagogic after-effect, leaving a trace of an altered affective state in the perceiver. I think this suggests some success in achieving an immersive exteriority, but inevitably listeners apply an interiority.

[108] Derived from the regions $7^0 = 1$; $7^1 = 7$; $7^2 = 49$; $7^3 = 343$; $7^4 = 2401$; $7^5 = 16807$; $7^6 = 117649$; $7^7 = 823543$.

The opening scene has been described as nocturnal and containing entities, possibly biological creatures or agents of some sort. One listener described that their senses were being played with, being manipulated through sound, with fluctuating anxiety and relaxation levels, and described it as being moved from one life state to another. Several listeners commented on a nested revelation unfolding from the opening synthesis, revealing fragments of recordings, which reveal instruments, which in turn revealed a cultural/geographical location specific to the Middle East. These listeners experienced the daf as arriving from another world.

With its technological artefacts, the medium itself becomes salient as gated noise cues its artificiality (perhaps characteristic of techno/dance-music production). As the semantically referential gradually superimposes, the piece moves from an entirely synthetic to a more concrete instrumental (percussion and santur) and acoustically 'real' world, particularly as the disrupted *maqam* appears.

5.6 Summary

This triptych assembles conceptual sign qualities of trace, making critical reference to the specifically Islamic and currently charged geopolitical context that motivated these works. They perform a definite 'bracketing in' of associations, inverting a Schaefferian play with ideal objets sonore, exiting the acousmatic. *BGZ* specifically contests Orientalist notions of soundscape, using specific trace to investigate the world by electroacoustic means, critically questioning assumptions, intensifying fearful affects and taking a definite position with respect to its material with the intension of exerting effects in its vicinity.

Makharej investigated embodied vocalisation, hybrid studio and real-time performance-composition, and the challenges of human-computer interaction. Ownership and authority of language was explored, chimerically transiting and rupturing semantic-linguistic, affective and sociocultural domains.

The Remainder experimented with deploying mathematically inspired approaches to form, seeking to generate and emphasise evental flows and affectivity but without necessarily rejecting linguistically tied semantic reference.

These works alerted me to the difficulties outlined in the first two chapters, and initiated my BPS theoretical regrounding proposed in the following two. Through my travels, experiences of the sama' polemic, and implication in the sonic cultures that I encountered, I became acutely aware of the deficiencies in the discourse that had initially appeared to be relevant: soundscape theory and acousmatic practices. They brought me to reflect upon the culture-bound nature of authoritative discourses, to inquire into their premises, to search outside, and to think sound not as an object. Rather, the practices of composing sound thinking overlapping and adjacent to language.

Chapter 6

Live assemblages

This chapter focuses on live work. In terms of a BPS_paC, the discussion draws together threads from Part 1. The first piece (discussed in section 6.2) is *Batroun Concrète (BC)* which was initiated as I completed *BGZ* and *Makharej*. It is a hybrid, using fixed electroacoustic parts and (in the second version) live site-specific improvisation structured through a score.

The studio-based improvisations and experimentations generating *Makharej* necessitated rapid and intuitive negotiation of the RIA-helix when prototyping and deploying synthesis patches. I developed the *m-Log* (outlined in section 6.1) to facilitate we-centric exchanges with Amira's embodied immediacy, which was subsequently used for the live *Reed | Skin | Elektrik (R | S | E)* solo performance discussed in section 6.4. This performance ecology[109] became the initial version of the *hQi.live* assemblage (section 6.3) which models the RIA-helix, retaining key elements as it evolved across programming environments. The second iteration, *CoP.live* (section 6.5), was developed for an improvisation trio which engaged John Cage's ideas of indeterminacy. Its salient features are briefly discussed, as it developed into a third iteration used for a show called *Dark Geometries (DG)* which is discussed in section 6.6. There is some continuity between the fixed compositions of the previous chapter, and the improvisation-based works discussed here, and I consider them to be on a continuum in musical mentalization and RIA terms[110].

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[109] I use this term to emphasises electroacoustic performance' reliance on navigating the total possibilities for action afforded by the contextualising environment and network of performance 'objects' which typically include a hardware-software environment, and the listener/performer located in a physical diffusion space. It foregrounds distributed cognition and is developed from the work of Gibsonian ecological psychology, Occupational Therapies, and electroacoustic music studies (EAM) (Gibson 1966; Dunn 1994, Waters 2007).

[110] This was discussed at the end of Chapter 3 Section 3.6.

In the optimised conditions of the studio, the dynamics of the listening-stance and predictive helical modelling affords greater out-of-time reflective function which allow the sonic-surface, the effects of the listening end state, to be iteratively reworked and eventually punctualized into a final version. Live performance is necessarily more provisional, and for me, often generates anomalous moments and unexpected trajectories that would not have occurred otherwise. Such encounters are a key way of exercising the not-knowing stance, an experimental approach to generate new epistemic things and to find what a given assemblage might do.

It is not simply that the real-time arrow of 'now' operates largely unidirectionally and that mistakes cannot be retrieved. The key difference is in the operations of structural coupling through we-centricity. In common with many electroacoustic composers, my studio practice is primarily solo, promoting an absorbed reflectivity which tends towards the obsessional as possibilities proliferate and details are scrutinised. In live work, one is engaged with agentive social others – either human musicants, or non-human machine agencies in a rather different pace of exchange.

While it is said that composition is akin to monologue, or a carefully crafted novel, whereas improvisation is a discursive exchange, I think the language analogy breaks down. It is the adjacency to linguisticity that I find most salient: the presence of largely non-conceptual musicogenic affects and 'meanings', contagious gesture and developments of form from local to more global structures.

When we consider improvisation, gestural exchange and creativity does not refer to things, but rather gives life to and embodies actions which permeate through musicants and into audiences. Interacting bodies couple through we-centric exchange, exogenously driven by the co-constructed sonic field. These gestures are not simply reworkings or transformations of compositional diagrams (traces in a software environment or in a score), but they replace these objects by enacting sound without necessarily referencing a compositional intention.

While such improvisational gestural creativity may not be scored by a composer, they are nonetheless scored. In idiomatic improvisation, genres norms operate which structure and constrain the exchange - certain progressions are codified in shared practice, certain developments are in style, and others do not find a place. In the case of free-improvisation, we see structure emerge, usually from local-level to macro-level scale, where an initial set of gestures organise outwards to larger scale developments (Borgo, 2005). Present-trace develops moment-to-moment dependencies which may become elaborated, sometimes into long-distance trace (see section 3.3.4).

David Borgo draws attention to the idea of 'attractors' (in the thermodynamic or chaos mathematics sense) which operate as organising tendencies within complex or chaotic systems. Such systems may have resting states determined by areas of relative stability, and under perturbation, they can shift from one such state to another overall exhibiting nonlinear dynamics. William Benzon - considering entirely different musics such as Beethoven and African talking-drums - argues that attractors operate when we entrain rhythmically with sound (Benzon, 2001). In BPS terms, I suggest that improvisation exchanges mental state attractors through the vectorial relations of we-centricity across a group matrix[111].

Contagious gestural figurations pattern the ST space and timing in the exchange, sometimes symmetrically and reciprocally, at others reflectively and asymmetrically (under C-stance). I think apophenic process comes reflexively to the fore as 'meaning' is co-constructed with the emerging sound. Composition and improvisation have differing strengths in organising gesture - the former more reflectively (and often explicitly organised into signs), the latter in a more immediate and embodied flow (tending to the evental). But both are subject to our innate drive to find pattern as interiority and exteriority.

❊

[111] See my earlier discussions in Section 2.3.1 on Bion's vertices of projection in the matrix; symmetrical vectorial relations between subject models and evental flows in Section 3.5.1; and, Figure 15 diagramming the biopsychosocial sonic assemblage in Section 4.4.

Developing the notion of 'listening without a listener' from Chapter 3 the PSMs of musicants synchronically imitate physical and mental gestures which transform both their inner structures (the spatially strictly internal physiological and neural substrates of the biosystem) as well as their pulsing interactions and teleofunctional relations to things that lays beyond the boundaries of the physiological body. Such exchanges have a basis in the neuro-social manifold. This organisation does not require a humanistic notion of a sovereign or transcendent subject-conductor or originating logos[112]. Rather, such synchronisations are emergent from systems that form on-the-fly coherences, through the coupling of attractors that organise the activity on BPS networks. Both biology and culture is relevant to how these proceed.

❊

In Chapter 2, I mentioned Judith Becker's term 'habitus' (2001) which constructs 'what music means, what it is for, how it is to be perceived, and what might be appropriate kinds of expressive responses' (ibid: 137). Every listener occupies a position within a BPS field which is not of his or her own express making. Like the aesthetic regimens of Chapter 4, habitus of listening is a tacit, implicit, unexamined and apparently natural embodied pattern of action and reaction of which we are not fully conscious. It is not a rule but a preparedness which disposes us towards a listening-acting focus. It sets up expectations, sensitises us towards stylised gestures and biases our interpretation of sound and attributions of meaning.

[112] I do not mean to imply that improvisers do not form specific intentions or adopt explicit strategies, only that these goals may only partially determine the end result. I suspect that introspected intentions may often be post-hoc linguistic rationalisations rather than causal mentations. Mentalizing is usually reduced in conditions of high arousal (emotion) as is common in performance. It subserves the capacity through which we suppress the prepotent (impulsive) actions set in train through perception (discussed in sections 3.1.2 and 3.5.1). Rather than believing that we choose to undertake certain actions, it is more accurate to suppose that we choose not to suppress certain impulses. This is what Benjamin Libet calls 'free won't' or 'the power of veto' by which we let impulses through to actualisation rather than dampen them down (see for example Libet et al., 1983; Wegner 2002; Obhi & Haggard 2004).

Crucially, this construction allows not only for the listening-composing (improvising) mind to be situated within a shared BPS context, at a particular place and time, but also has room for the singularities of individual listeners' episodic biographies. Culture and biology sit within a single plane. Listening and music-induced emotion arise as scripts that involve supra–individual biological and cultural processes that have arisen through personal, evolutionary and historically conditioned processes.

Borrowing from Maturana & Varela (1987), and like Benzon, Becker suggests 'structural coupling' as a process to describe the way in which an organism, interacting with other organisms and with a world, changes its internal structures. I will not enter detail, but 'composite unity' is key (Maturana and Varela 1987: 78). The same processes operate whereby successive stages of composite unity give rise to higher-order structure - from the cellular, to the multicellular, to the organ, to the physiological system, to the biological individual, to coupled groups. Once organisms with a nervous system arises, 'if the organisms take part in recurrent interactions, these couplings will occur – with definite complexity and stability' (ibid: 131) giving rise to higher–order couplings. Maturana & Varela demonstrate (by discussing penguins, sticklebacks and social insects) that social dynamics can arise as biological phenomena through self-organising (autopoietic) process. Units (such as cells, or organisms) establish working synergies after they have developed habits (note the connection with Peircean semiosis) that correspond to and co-adapt with other's behaviours to create emergent systems that come to form further units.

This self-organising coadaptation applies as much to the social organisation of sound as to other sets of social relations. Rhythmic entrainment provides a good example which:

> [...] can be seen as structural coupling, of a changed interior, as a personal consciousness in a musical domain of coordination. Bodies and brains synchronize gestures, muscle actions, breathing and seemingly brainwaves while enveloped in music (Becker 2012:64).

The sonic surface envelopes the listeners and provides a driving, pacing stimulus. Coupling appears to be emergent from BPS systems through structuring 'scripts' (or schemata or attractors). These scripts are multiple in nature, being biological and cultural.

An array of biological 'scripts' structure the listener's perceptions–and some these subpersonal systems have been introduced in Chapter 3 under the K-matrix. These biological schemata constrain the behavioural repertoire of the listener-composer's gestural responses. The cultural scripts have been successively embellished often over many hundreds of years of supra–individual practices, giving rise to formalised group process. The biopsychosocial elements combine into a habitus located within a BPS field which changes over time. As Becker notes, as the interactions change so to do those who are interacting – both internally and externally. From the Peircean perspective of Chapter 4, these habits are formed through the modelling of the triple helix.

❊

Personally, during this research, I have oscillated between fixed and live works, with the latter providing a much-needed reprieve from the former. The computationally based and time-intensive work for *Makbarej* and *BGZ* no doubt was related to the work of *BC*, which largely eschews intensive studio-based trace transformations. This oscillation led to parallel developments of my BPS_paC, with the fixed works coming to focus on the themes of Chapter 5, especially the domains of AOs as semantic signs, syntactic dependencies, linguisticity broadly, and evental exteriorities. The live work led to a focus particularly on coupling, schemata or scripts, adopting a not-knowing mentalization stance; demands on the K-matrix and RIA helix; and, my application of re-entrant loops based on mnemonic trace structures.

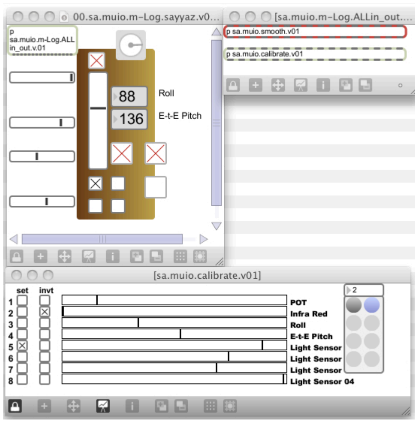
6.1 m-Log and al-Farabi spatial synthesiser

Control interfaces can notoriously impair perception-action coupling, adding haptic distance from synthesised sound. In live performance, the opacities of the laptop GUI can divert significant cognitive resource, and the range of possible physical gestures and number of simultaneous degrees of freedom afforded by an interface greatly determine the scope and nuance of performance.

In section 2.2.1, I introduced Guerino Mazzola's musimathematical discussion of 'functor' as the set of perspectives on an object; the set of vectorial relations between perceiver and object. This was further considered in section 3.5.1 in terms of gesture. Of these gestural relations, pointing (with a finger) is the most fundamental, which (not coincidentally) is the most basic haptic relation to sound through the laptop trackpad (Mazzola, 2014). While this may function well enough in many situations, it is often inadequate to affording the nuanced and transparently agile embodied coupling required between improvising performer and digital sound. This basic observation has spawned a new industry for musical interfaces and associated conferences (see discussions in Wanderley and Orio 2002; Allen et al. 2006, Miranda et al., 2006). From my BPS_paC perspective, this is a question of how to instrumentalise the RIA helix.

a b c d

(A)



(B) (C)

Figure 31: (A) Four views of *m-Log* (B) *m-Log* in performance, *Makharej* live duo at MazaJ: Volatile Frequencies, City University, London, 2010 (C) Max/MSP control screen

My solution was the *m-Log* (Figure 31A) built using the muio expandable USB platform, which is like Arduino (Symons, 2011). It has an accelerometer, tilt and roll sensors, four light detecting diodes (on the side in 31A: d, and under the fingers in 31A: c), an infrared sensor (on the front in 31A: a, and 31B), four push buttons (31A: a-c), four toggle switches and one potentiometer (under the thumb in 31A: b).

In *R | S | E* and *Makharej, m-Log* was paired with my 'al-Farabi synthesiser' (built in Max/MSP), a microtonal FM/additive synthesiser based upon al-Farabi's tunings, with harmonics distributed spatially across multiple speakers.

The *m-Log* offers gestural transparency and immediacy giving an intimate sense of touching sounds through the RIA helix. It sits comfortably in the right hand, and affords bimanual control especially when using the infrared sensor as seen in 31B. It is sensitive to 3D movements through the tilt (on axis deviation), roll (around axis deviation) sensors. The accelerometer allows a useful 'effortful throw' motion.

The muio board generates a significant degree of jitter, adding low-level fluctuating indeterminacies to the output control signals. While others may regard this as a problem, I found this intrinsic activity (crudely) analogous to the spontaneous neural activity discussed in Chapter 3 in relation to apophenic processes in AO formation. The jitter can be smoothed in the software (shown in 32C), but I often used it as a source of spontaneous signal merging with manual gesture (discussed in *R | S | E* below).

6.2 Batroun Concrète

6.2.1 Assembling material speculations

I shall narratively discuss key aspects of this assemblage (Figure 32). *Batroun Concrète 0.0* (2011) was commissioned for the opening of the Batroun Projects art space in Lebanon. This initial version is not submitted. I made a series of site-specific performances-to-microphone

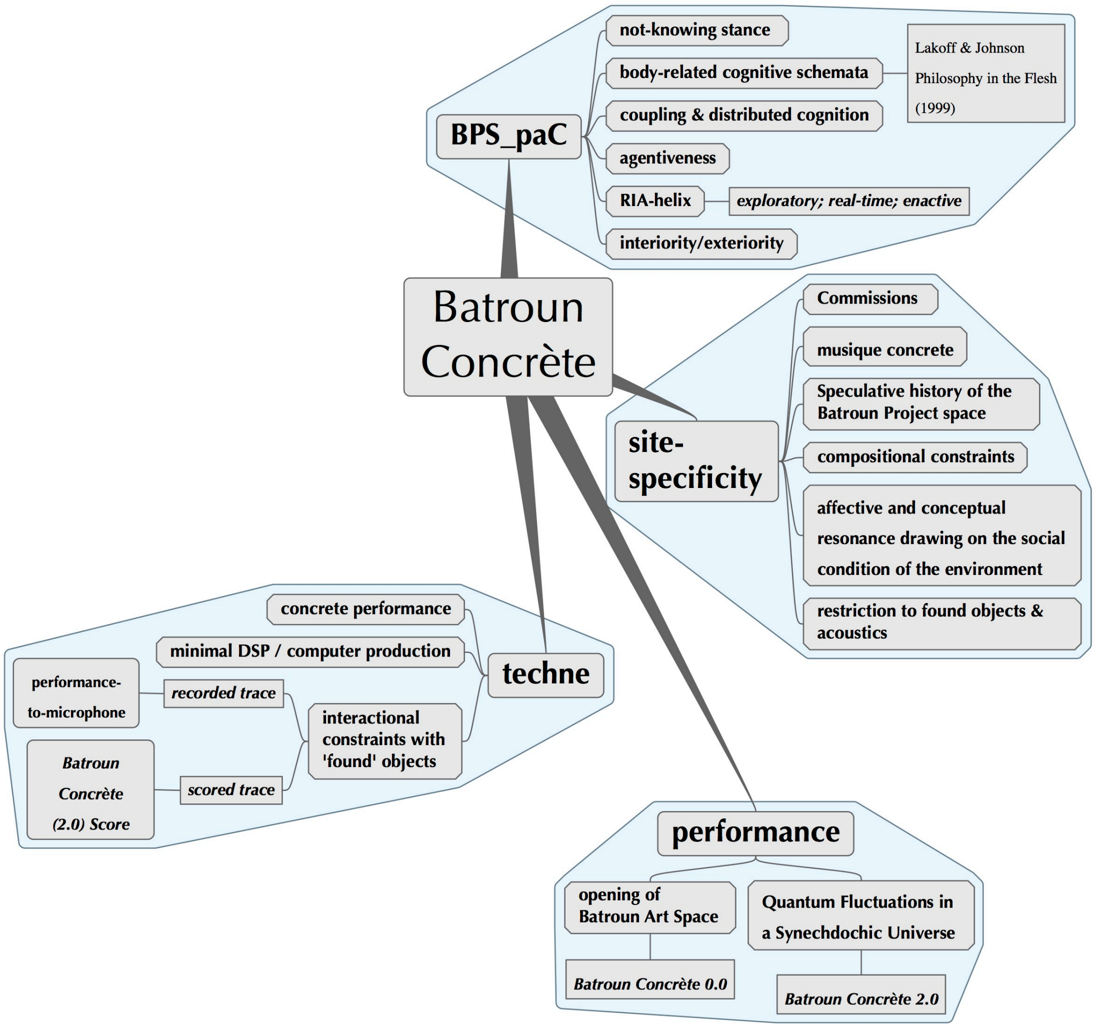


Figure 32: Key elements of the *Batroun Concrète* assemblage

using only found materials, sonically activating the site, intervening to bring various properties into aural focus.

My intentions were to investigate the possibilities of structural coupling between a performer and the specificities of an environment; to speculate upon the nature of 'scripts' which structure musicking; and, to make a *musique concrète* that largely escaped computational transformations and with only minimal editing of performances. It focused on BPS processes 'in the raw' – somatic interactions with material entities enactively generating affective and conceptual resonance emergently, drawing on the social condition of the environment. The listening stance was one of not-knowing in advance what was possible, with the intention of exploring the affordances of materials through distributed agency.

The work subsequently developed through a second invitation to a festival called *Quantum Fluctuations in a Synechdochic Universe* curated by Sara Giannini and Fatos Ustek for the OuUnPo collective in 2012 at the same site. This version has five electroacoustic parts (assembled through edits of my initial encounter with the space) that interleave with four site-specific improvisations structured through a score. The electroacoustic parts *Batroun Concrète 2.1, 2.3, 2.5, 2.7, 2.9* and the score are submitted (see Appendix A 1.05). Unfortunately, there is no completed final performance documentation. Site-specific works are prone to site-specific problems. Scheduled for December 2012, the Syrian civil war was already creating repercussions in Lebanon. It was determined that it was unsafe to go ahead and the performance was cancelled.

6.2.2 Batroun Concrète 2.1–2.9 (2012)

Batroun Projects is a multi-story house by the ocean in the north of Lebanon. Its high vaulted ceilings, arched doorways, exterior and interior spaces and concrete appendages had been abandoned for many years. Fresh water flows from a well under the house and out to the sea. The purposes behind the construction of the house invite speculation. Built in the mid-1980s during the war, it was never completed, hit by an artillery shell and abandoned. Its proximity to a Syrian checkpoint at the time is conjectured upon. No other structures in the area were targeted.

Perhaps the structure of the house contains certain clues. Its construction of concrete, multiple rooms, and typical flat roof are unremarkable, giving the air of a thwarted seaside villa. There is a contradiction between its external and outward facing aspects and its internal spaces. Hidden within are a series of interstitial spaces, false floors, and secret storage recesses; in the basement lays a partially sealed, huge and mostly inaccessible void. A tunnel runs from the basement down to the sea, not visible from the road. A place in which to hide and transport contraband. If so, what was it intended to store?

My compositional approach drew from this sense of speculation and not-knowing. It has powerful resonances – acoustically and metaphorically. These determined my initial encounters with the space and the later scored improvisations. The score describes a set of specific constraints to construct traces of my compositional activities.

Constraint 01: Objects are defined as any materials found in and around the Batroun Project. Only these may be used, in conjunction with the architectural acoustics and recording / amplification equipment. This limited the emergent interaction entirely to the space, using only found materials to explore the sonic affordances.

Constraint 02: In live performance, the agent(s) are free to couple themselves, in any way suitable, with the objects and the acoustical space, forming an assemblage for generating sound enactively.

This constraint emphasises the specificities of that particular place. The work is the specific assemblage of people, materials, acoustics and associations, at the particular time and conditions of the performance. This resulted in a series of focused performances-to-microphone (in my initial encounter), coupling myself (and potentially other performers in the second version), materials and acoustics into an assemblage to enactively receive/interpret/act out what might be possible through a not-knowing stance. This resulted in intensive listening, acting and recording that paralleled my development of mentalizing sound and the listening stances described in Chapter 3. Speculative improvisations placed me in uncertain relation to the spaces' resonances and associative conceptual atmospheres, without the introduction of extraneous instrumentation or other technologies.

The resulting recordings (in *BC 2.0*) are not 'the work' to be preserved. The aim was not to document an endangered soundscape or transitory moment[113], but to trace an encounter with, and sonic speculation about the space – to investigate through electroacoustic means what it could do when coupled with enactive imagination.

113 Such a stance is characteristic of authoritative acoustic ecological and field recording composition traditions.

Constraint 03: The purpose of the live performance parts is to structure what a sonic assemblage can do, to find what might be possible. This third constraint follows closely from second. The intention is to give full latitude for any action that explores the sonic potentials inherent in whatever way the situation affords, so long as it is consistent with constraints 1 and 2.

Constraint 04: The intention is to trace the unfolding enaction between performer body-objects-acoustic-ears. Once the assemblage is sounding, trace cannot be retrieved, only reconsidered, embellished, or abandoned.

The fourth constraint was to emphasise real-time situatedness, and not to regard the recordings as source material for potential '*objet sonore*' to be resected by later studio manipulation. There is an obvious play on the *musique concrète* tradition. I wanted to return to the recording and collage techniques of the early pioneers using the (literal) concreteness of the sounds, but with only limited large-scale editing. There is a temptation to 'improve' the materials by detailed selection and arrangement. This introduces questions as to how these choices are made, and raises the problem of 'ideal' performance, of conforming trace to expectations that arise from beyond the situated performance.

In *Makharej* and *BGZ*, I had engaged in meticulous editing and signal transformations and wanted to capture the provisionality that arises from a not-knowing stance. The result includes materials that are less than ideal from a sound engineering (C-E) and acousmatic compositional stance (C-I and C-E). Given the conceptual derelict nature of the space itself I did not clean up 'imperfections' in either the trace or in the performances that I made, imparting a certain honesty to the signal of the final work[114]. My approach had more in common with my work as an improviser, where the RIA demands require a real-time, irretrievable, and provisional stance.

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114 This relates to Cross and Woodruff's (2008) idea of music as 'honest signal'.

6.2.3 Diagramming Batroun Concrète

In preparing the initial electroacoustic piece (for *BC 0.0*) and the EA parts for *BC2.0*, trace recordings came about through exhaustive experimentation with concrete and assorted rubble, various granular material such as sand and pebbles, pieces of wood, broken furniture, and various other found bric-à-brac. I made basic instruments from the detritus such as an aerophone Bull Roarer from wood and rope, various flutes from pipe and bottles, and percussive contraptions from membranes and the hollow bodies of pipes.

The spatial 'where' aspects of the resulting AOs had specific characteristics. The basement was highly resonant with a very bright acoustic due to the concrete walls. By contrast the upper stories had no windows, and as one moved the sounds of the sea and nearby town intermingled with the proximate traces of my footsteps echoing from walls. The secret partitions, corridors and recesses had their own characteristic impulse responses. The casing of the well under the house was cracked affording access to a large resonant cavity filled with aqueous traces. My actions and listening became coupled with the different acoustics, moving between reflective-reflexive and interiority-exteriority stances. Through prolonged periods of absorbed activity, I found myself lost in a heightened sense of embodied aurality. These lengthy improvisations were interspersed by close listening back to the resulting traces.

I quickly became aware of parallels between the body of the house and my own body. I thought of the scripts of Lakoff and Johnson's *Philosophy in the Flesh* (1999) who argue that basic somatically originated schemata act as metaphors (cross domain mappings) that structure thinking and language. They apply equally to musicking (see, for example, Zbikowski, 1997; 2002; 2008).

In Chapter 3 Section 3.3.1, this common neural format between perception and action is discussed through Prinz's notion of 'common coding' where RIA modelling predictively codes perception and inference in a single, hierarchically organised system, selecting between future-orientated 'interpretations' to generate an iterative best fit. The constraints just described seek to focus on aspects of such enactive-perceptual codes.

I had noted regularities in my enactive production of sounds. Reflecting in the studio, they could be grouped according to their generation by the various body-related cognitive schemata described by Lakoff and Johnson. This led to my research discussed in Chapter 3 concerning sonic salience, mnemonic traces and Cue-Abstraction (Section 3.3.3). This work highlights procedural trace – largely non-verbalisable knowledge about sounding that is non-conceptual. This is placed within a conceptual structure – the potential linguistic meanings of the house discussed above, and reflection upon the enactive syntax that structures the nested hierarchies of action and perception (discussed in Section 3.3.4). These considerations informed my organisation of the recorded materials into discrete parts, and the later *Batroun Concrète Score* (2012). Before discussing the score, I shall outline the core body schemata used[115].

The Container Schema (Lakoff and Johnson, 1999: 31) is a bounded space within a region, a structure that identifies the boundary of the interior as the landmark and the object overlapping with the interior as a trajector. It has an 'in' and an 'out', implying an interior-exterior relation. The container protects its contents, restricts their motion, and renders them inaccessible to vision.

The Source–Path–Goal Schema (ibid: 32) is a trajector that moves from a source location (the starting point). A goal is an intended destination of the trajector forming a route from the source. The actual trajectory of motion is of interest compositionally. The trajector has a position and a direction at a given time. The actual final location of the trajector may or may not be the intended destination.

[115] Lakoff and Johnson's original terms are capitalised.

Bodily projections (ibid: 34) refer to the way in which our bodies shape our conceptual structure. These core body schemas include the relations of body orientation: in front of/behind, front/back, left/right, orientation from the source, and localisation.

Image schemas and elements of spatial relations (ibid: 35) is a relatively small collection of primitive image schemas that structure systems of spatial relations in the world's languages and these were born in mind: part–whole, centre–periphery, link, cycle, iteration, contact, adjacency, forced motion (e.g. pushing, pulling, propelling), support, balance, straight–curve, near–far.

⁂

The frontispiece of the score gives the floor layout for the building. Page 4 outlines equipment and methods for performance. The piece is structured in nine parts labelled 2.1 to 2.9. The work pairs precomposed electroacoustic parts with interleaved live performances. Each pair has a title that relates to the core schemas. The score includes standard amplitude-time plots so performers can orient themselves when the electroacoustic parts are played. Each live part has a series of images that I relate to the core schemas and provide a graphic notation open to interpretation.

The live parts may involve any number of performers and may be of any duration. The equipment required is straightforward – two high-quality loudspeakers for stereo diffusion at a volume set to the level of the room to achieve an immersive intensity. Two microphones and a mixer achieve amplification of objects that are to be used in the live performance.

The performers define their own choice of material, played acoustically or amplified. Constraint 3 encourages attention to the sonic possibilities, including the responses of people present and the conditions of the building at the time (it is close to the sea and weather conditions change that significantly alters the acoustics and the environmental sounds). Constraint 4 is to avoid tentativeness, but also to give ownership of the process; the score does not specify any particular sounds or particular temporal structures.

Each live part contains three pictograms that relate to the core schemata which structure both electroacoustic and performance response. When working with improvisational methods, although text can be helpful, the presentation of visual graphics and symbols unsaturated by language can encapsulate the concept with an immediacy that can be apprehended during the real-time constraints of performance.

There is an intended relationship between each electroacoustic part and the performance that follows it. *BC2.1 Consider a decay …* serves as an introduction structured by the Container Schema and Source-Path-Goal Schema. The opening of 2.1 is dominated by the sounds of water and objects being dropped into water inside a resonant cavity; however, once this is established, other contradictory spaces insert into the sound field. The traces of objects dropping into water pick up a rhythmic motif creating a sense of a trajectory and development. Investigations of impact-resonance-silence can be heard via quick decay times and long acoustic reverberations, near-far relations, and superimposed spaces that cannot naturally coexist. This last point is emphasised in the electroacoustic part because it cannot be performed in the real space, revealing their technologically mediated nature.

The paired *BC2.2* and *2.3* are structured by bodies making contact (echoing O'Callaghan's Relational Events View in section 2.3.2). These traces exist in acoustic space and have trajectories that begin in one spatiotemporal location and proceed to another. The score draws attention to periphery and centre. Sounding actions accumulate in reverberant space. The rapid succession of impact-resonances caused by objects being scraped around the periphery of various rooms in the electroacoustic parts encourage a fusion of individual sonic gestures creating enfolded spectra as the sounds and their acoustic tails overlap. Figure-ground differentiation becomes increasingly indistinct, creating conditions of noise where focal attention becomes difficult.

The core schemata for *BC2.4* and *2.5* are source–path–goal, bodily orientation and bodily projection, and spatial–relations, poetically mapped onto the concepts given at the bottom right: ambulatory–ambulant; rhythms have a gait; organise pitch and breath; the human form is a reference; pace and oscillations. *BC2.5* is dominated by my body running continuously around a large debris-strewn room. The oscillatory motoric activity creates a rhythm, the rate of which varies. The physical exertion indexed by this trace is echoed by the presence of breath, but in a rather tangential fashion. The breath takes the form of organised pitch from flutes created from pipes and bottles and played with the same technique as the nay. This not only indexes breath and exertion, but may also symbolically refer to the MENASA context.

BC2.6 partially revisits *BC2.1,* concerned with the containment of bounded space constructing related interior and exterior. The boundary protects and restricts the motion of what it contains, rendering its contents invisible to the exterior. *BC2.7* refers to impact resonances and decay structures that were present in the *BC2.1* and articulated such that one space opens into the next creating a series of containers. The performer in part *BC2.6* is encouraged to move away from the sources of *BC2.1* and to consider their choice of objects in relation to *BC2.3*. The score draws attention to static sources and surfaces that rotate at a centre, intending to emphasise location and presence. In *BC2.7*, a telephone mediated conversation appears – implying someone who is not present. This telepresence is a kind of doubling. First, we hear the disembodied voice in the shared interior. Secondly, we infer a conversation with somebody not here, exterior to the Batroun location.

BC2.8 and *BC2.9* take a more esoteric turn. The core schemata are contact–adjacency, container, iteration, cycle and approach–recession. *BC2.9* opens with exploratory traces of granular materials being disturbed, in parallel with a bounded space in which burning objects drop repeatedly into the water tank. It is possible to hear references to earth, fire, water and air. The latter is signified by the appearance of a Bull Roarer (at 17:48), fashioned from objects at the site.

To close this discussion of *BC*, I think it successfully returned to the concrete sonic specificity through assembling site-specific materials and interactions. The score specifies biological scripts, body-related schemata as gestural syntax to structure the interaction of the performance body with site. There is no direct compositional determination of the resulting sonic surface, and performers were given great interpretive latitude to foreground an experimental and not-knowing stance to listening as an exploratory and motoric behaviour.

I feel it is a shame that the intended performance of *BC2.0* was never realised, nor will it be so, as the space is no longer in operation. In that sense it is a failure; however, the general approach is eminently applicable to other contexts: the sonic specificity of coupling with a location and context; site-specific improvisation structured through classes of enactive schemata; the pairing of a live performance with an EA part to make audible, comparative RIA modelling by different agents responding to the same context and materials; and, the idea of 'honest signal' that captures situatedness in its pragmatic provisionality rather than idealised form.

6.3 hQi.live

The following three sections discuss an approach to live work that is at the other end of the technological spectrum from *BC*. *hQi.live* names a lineage of performance ecologies that incrementally elaborated the tripartite RIA processing model. The general assemblage is shown in Figure 33. There are three versions, each associated with particular performances: *R | S | E, CoP.live*, and *Dark Geometries (DG)*.

hQi.live responds to the BPS_paC elements shown at the top right of the figure. It follows the same basic RIA model as used for *Makharej*, but for real-time application. The generic structure is shown (top left). An acoustic space (instrumental sources, room sound) is received (via microphones) into a reception software layer. Traces are recorded into differing memory buffers.

Various 'interpretive' functions operate on this material (instantiated in software algorithms and by operator choices) that pass to a 'response / action' layer, resulting in audio output to a variable number and type of loudspeakers. The resulting sound re-enters the reception layer over several time frames, affording various emergent properties.

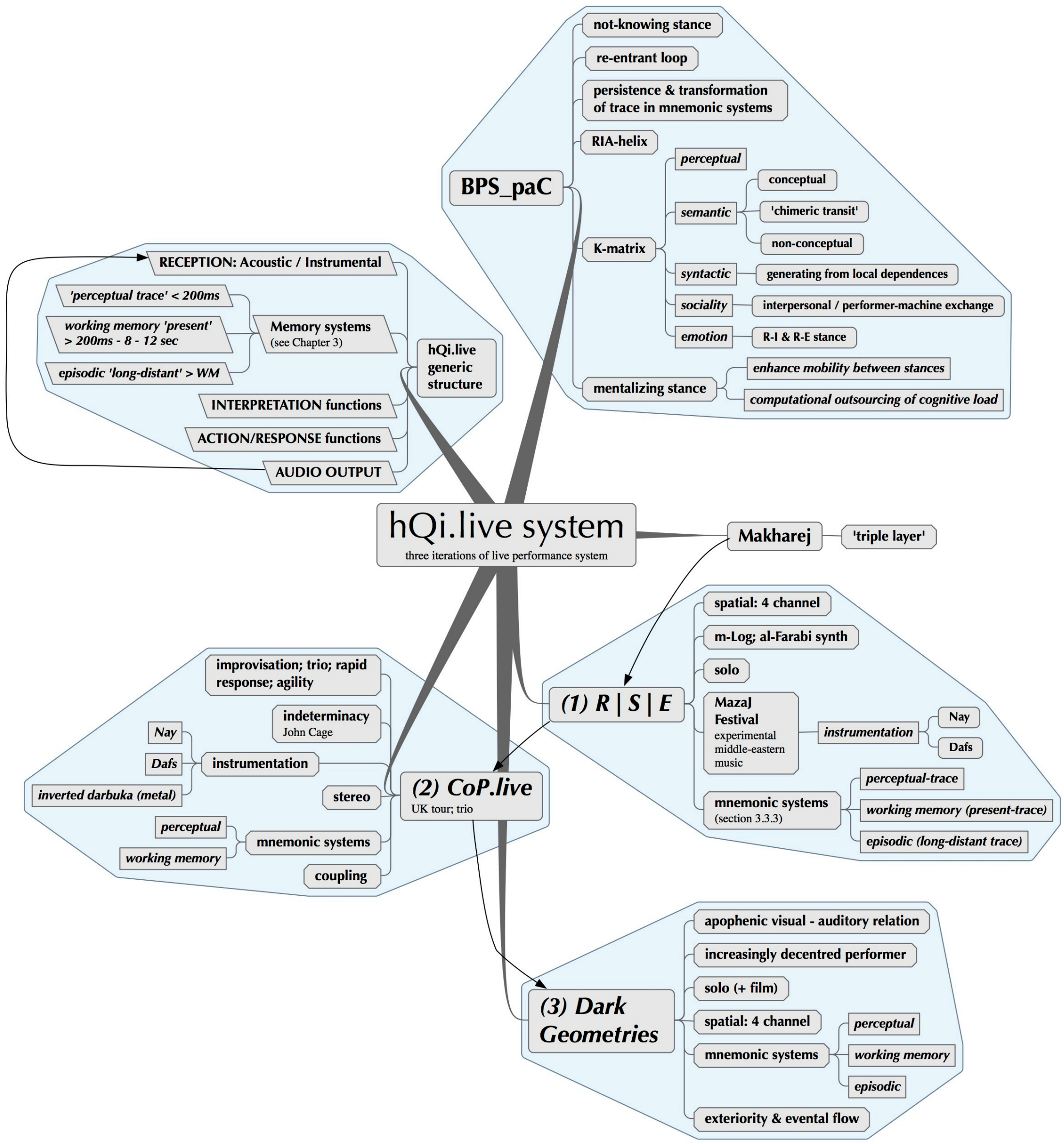

Figure 33: Key elements of the *hQi.live* assemblage in its three iterations

R | *S* | *E* was a standard electroinstrumental set-up using live sampling and transformation methods guided mostly by operator choices. *CoP.live* added indeterminate noise and stochastic based modulators to the internal interpretive control streams. It implemented a more explicit idea of the re-entrant loop discussed in Chapter 3, focused on the agility needed for improvising in a trio. The *DG* version moves towards decentring the performer, operating with greater algorithmic autonomy.

6.4 Reed | Skin | Elektrik

R | S | E was a solo improvisation at Cafe Oto, London, for the *MazaJ Festival of Experimental Middle Eastern Music* which I curated in 2010[116]. The 4-channel output system was implemented using STEIM's LiSa[117] and Max/MSP software with Korg microKontrol, Peavey 1600x, and *m-Log* controllers (the latter running al-Farabi synth) (Waisvisz and Baldé, 2007). Instrumental sources were nay, Persian daf, Arabic bass daf, assorted objects and various objects (tuning forks, rattles). An annotated view of the main software environment is shown in Figure 34 and a more detailed signal flow in Figure 35.

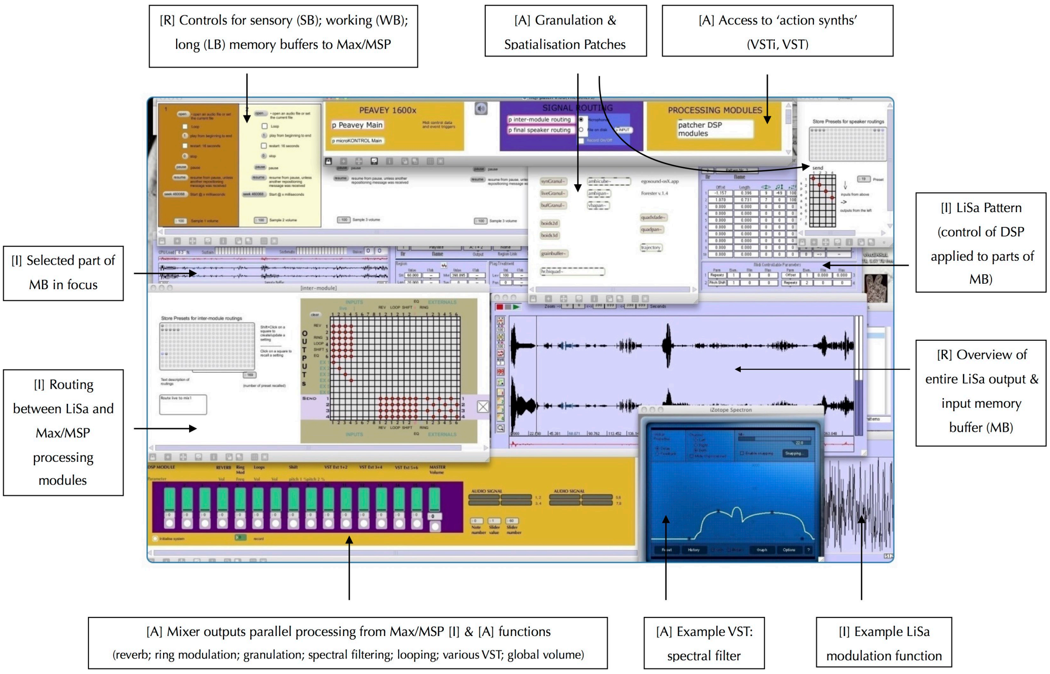

Figure 34: *hQi.live* main software environment for *Reed* | *Skin* | *Elektrik* in LiSa and Max/MSP ([R]: reception, [I]: interpretation, [A]: action functions)

Like *Makharej*, the system broadly models the RIA-helix. Reception [R] comprised of four microphones receiving instrumental sources recorded into discrete positions in the LiSa memory buffer (MB); three time scales of memory buffers sent to Max/MSP (emulating

[116] www.zenithfoundation.com/music/mazaj-festival/ and www.soundandmusic.org/projects/mazaj/

[117] For details of this program, see the discussion in Section 5.3.2.

perceptual, present and long-distance trace); MIDI controllers (Korg microKontrol, Peavey 1600X); and OSC controller (m-Log). Interpretation stream [I] was comprised of the native LiSa DSP sample transformation / synthesis processes; Max/MSP patches for VST, granulation and spatialisation processing; and, my interpretive decisions as performer-controller. This overlapped[118] with the action stream [A] comprised of the various output audio processes (from both LiSa and Max/MSP) to the sound card, spatialised over a quad loudspeaker array.

The main control windows show the two software environments, LiSa in the purple windows, and the others are Max/MSP. STEIM's JunXion software routed audio from the former to the latter. LiSa is optimised for live sampling and affords simultaneous recording into and playback from multiple positions, durations and rates of a large memory buffer, which can be divided to receive from and send to specific zones. These zones assign and automate various DSP processes (such as distortion, dynamic processing or pitch transformations). Various native processes can be applied to transform parts of the buffer, using a variety of wavetable, parametric envelopes, modulators and sequencing functions. Buffer access can be rescaled setting the start, duration and exit points, which can be controlled automatically and in real-time via MIDI.

The outputs of the system are continuously recorded back into the 'output segment' of the LiSa MB (Figure 35). Retrieval of instrumental source-traces and transformed audio system output, held in the main LiSa buffer (MB) was under automated sequencing, modulated by performer MIDI control, and organised according to the three the time-scales that were shown in Box 3 (set by buffer read loop durations) that fed into Max/MSP. The 'perceptual trace' (PerT) loop is less than 0.2 seconds, giving AO timbral transformations. The 'present trace' (PT) operated over working memory of up to eight seconds, and was the

[118] Consistent with my earlier discussion of the K-matrix and RIA-helix, these processes overlap. For example, a decision to respond to a moment in the performance by playing back a pitch-transformed and filtered content of part of the present-trace buffer is both an interpretation and a motoric action with immediate perceptual consequence.

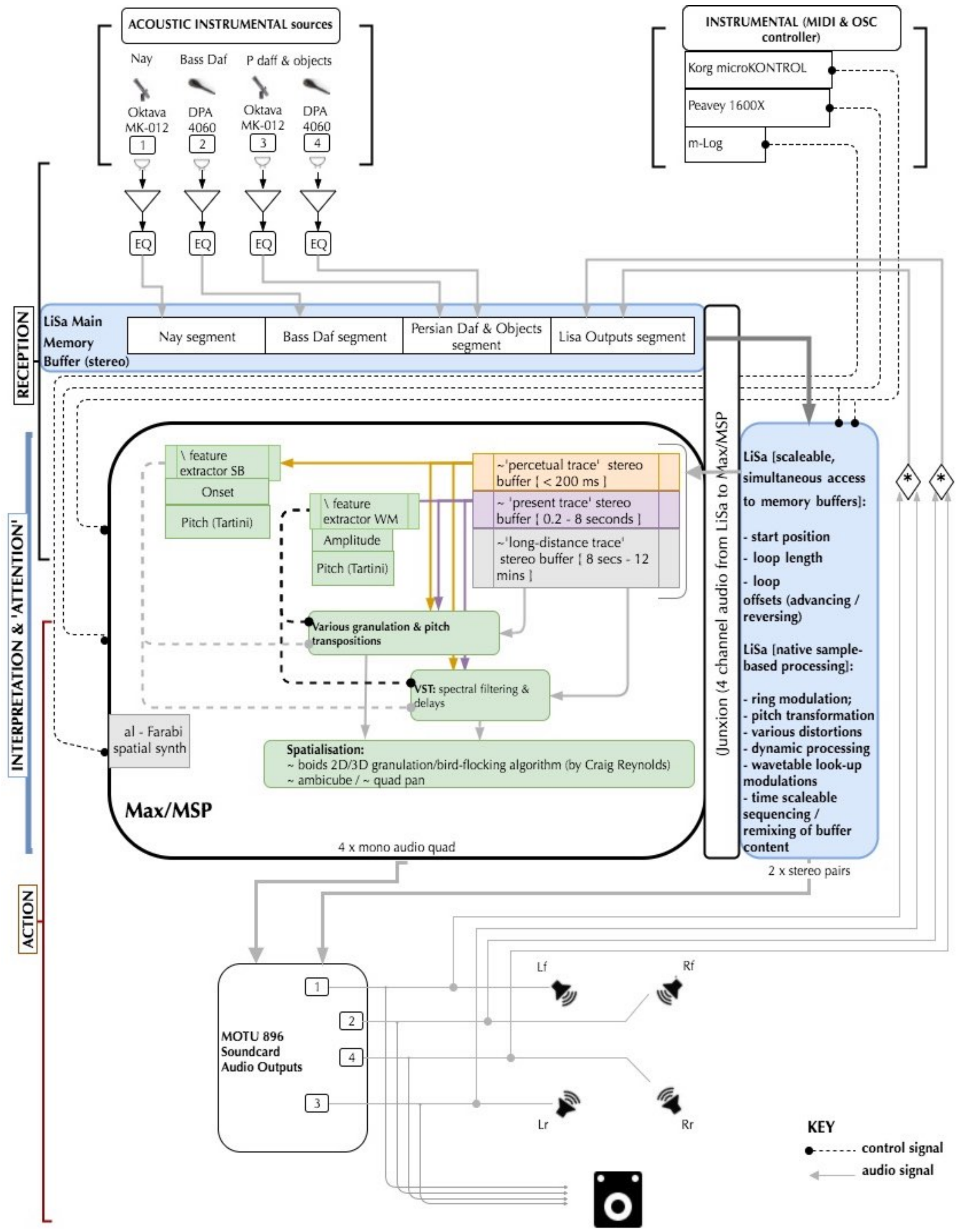

Figure 35: hQi.live signal flow for Reed | Skin | Elektrik

main work space, creating variable length playback delays, and transformed recurrences. The entire outputs of the system were continuously recorded, forming the episodic semantic memory 'long-distant trace' (LDT) of up to 20 minutes. Unlike *Makharej*, the PT and LDT contents can be directly heard at times (depending upon decisions made by me in real-time at the mixer).

The buffers could be transformed internally in LiSa, but were also routed to Max/MSP for FE analysis, DSP transformations and spatialisation. This routing was controlled via the [I] Routing and [A] mixer outputs. The FE modules automatically extracted trends averaged over PerT and PT, and included onsets, amplitude tracking, and fundamental frequency that parametised the action/response layer. Spatialisation over the quad was done directly from LiSa playback of discrete MB parts (directly to front and back stereo pairs), and in Max/MSP.

In performance, the automated (X system) FE analyses and LiSa sequencing freed me to intervene reflectively into the system as well as perform with the various instruments (as network components). Adopting a not-knowing stance, I was not certain of how the equipment would respond at any moment as I piloted the system as an improvisation partner.

I had several aims with *R* | *S* | *E*. Firstly, to return to live work and develop ideas from *Makharej*, taking steps towards a system that dealt automatically with 'low-level' processing – the reception inputs and action outputs. I was freed to focus compositionally on higher-level interpretation, able to reach into the input and output processes via a relatively small number of controls with one-to-many mappings, such that several related response synths and LiSa DSP transformations operated together. Secondly, I wanted a slowly evolving re-entrant loop that gave time for reflection on instrumental gesture and to hear material return in transformed ways over working and longer-term episodic memory, as an attempt to implement ideas of persistences and recurrences discussed in Section 3.3. Thirdly, I wanted a steady process of slow transformation to give a spacious sense of steady accumulating evental flow.

At the semantic level, the nay and daf conceptually reference their Islamic provenance, and both symbolically are associated with transcendental Sufi traditions. While the nay opens with a traditional *taqsim*[119], the aesthetic regimens associated with these are progressively disrupted. The overall emotional tone is somewhat solemn, reflective and even plaintive.

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Some of the recurrences of trace are obvious, others less so on the video (and submitted 4 channel audio). At the opening, the initial very brief nay attack triggers live processing on the PerT, releasing pitch transformations that obscure the acoustic instrument, and announces the agentive presence of *hQi.live* as the response far exceeds the initiating gesture.

From 00:41 to 2:40 the LiSa nay segment of the MB is steadily filled and audibly appears solo. At 1:15 the tongued attack on the nay is joined by processing operating in the PerT memory range, heard as a transformation intervening into the nay. At 1:03 slower evolving DSP transformations are suddenly evident, as extreme downward pitch transpositions are filtered and distorted.

By 2:40 the initial nay material is complete. There is a pause (the whole piece is intended to promote a reflective listening stance; hence, the sonic surface is kept quite sparse). At around 2:40, I return material transformed from the PT (short loops of nay, through a high-pass filtered delay line). At 2:57 (outside of the PT temporal range) the opening material returns as episodic trace with extensive parallel pitch and time-stretch PerT processing[120]. It is heavily compressed, generating a noisier and more viscerally active texture than in initial presentation.

By around 3:22 the vibrato of the nay gesture can be heard, slowed down as the playback head of the LiSa buffer loop gradually advances. At 3:31 there is a moment of *m-Log* in 'apophenic mode' creating high-frequency glissandi. At 3:35 I can be seen working with the *m-Log*, as the nay returns in highly distorted and pitch shifted layering. In this

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[119] *Taqsim* (Arabic: تَقْسِيم) is a melodic musical improvisation that usually precedes the performance of a traditional Middle Eastern composition.

[120] In the submitted video, I can be seen live mixing these algorithmic processes via the Peavey.

section, most clearly from 3:58, high-frequency activity is manually generated with the *m-Log*. I think of this as a crude analogue to the centripetal / centrifugal construction of AO discussed. The *al-Farabi* synth has received dominant frequency components of the initial nay. These are pitch-transformed upwards, driving additive sine waves. There is clustering in critical band widths merged with noise from the m-Log's internal circuitry, joining untransformed nay recurrences. At 4:56 we hear a rising pitch motif, again generated by the m-Log/al-Farabi synth with manual gesturing. At 5:51 I place the *m-Log* down in 'apophenic' mode, and we hear spontaneously fluctuating high-frequency material.

From around 6:00 the opening gesture returns, and I add to the LiSa MB, using a tuning fork to vibrate the bass daf skin. I can be seen adjusting various parameters (the LiSa zone processes, and Max/MSP processing) and at 7:35 a distinctive mid-high spectrum spatialised AO arises that has emerged from the earlier vibrated bass daf skin. Throughout, earlier materials are re-entering. At 14:30 short cycling recurrences are heard as antiphonal looping. As the cycle jumps along the PT buffer, the first cycling objects are replaced by another pair of objects, having the same duration.

At 15:21 a dramatic rupture arises, fortuitously derived from a glass breaking in the audience, picked up by a drum microphone but not passed audibly through the system. The section through to around 16:05 is relevant to the mentalizing processes that I discussed in Sections 3.5 and 3.6. I can be seen at the Peavey. I do not know what will happen. I distinctly recall being poised between high X-E, immersively engaged with the sonic surface and ready to automatically respond if the system runs away and becomes uncontrollable. I am rapidly oscillating with a state of high C-I, attending intensely and consciously to the interiority of the emergent sounds' apparent motivated behaviour and signification. I turn over possible lines of action in my mind, alert to forking potentials. While it may not be visually apparent I am in a very active state of covert behaving, with listening as action, linked to possible mentalized responses.

As the rupture trace cycles through the PT, it is amplified, slowed down, spatialized with slight delays between speakers, and distorted. It becomes a recurring syntactic trace (heard at 15:31; 15:44; 15:55; 16:03; 16:12; and then later at 18:24; 18:33; 18:39). At around 17:00, new material is placed into the PT derived from the al-Farabi synth. Through spectral-freezing, it becomes a harmonic drone, with distinct pitch structure which returns, pitch transformed downwards at 17:35 (and again at 18:11).

By 19:12 the chimeric texture has transited into a rather different sonic surface. The harmonic-drone material is still there, but a ghostly bass figure appears (such as at 19:32; 19:58) joined by al-Farabi textures. From an interiority there is a sense of stasis, then an entitative emergence (20:31) of an episodic recurrence, as a mid-high AO develops and dominates, under *m-Log* control. The ghostly figure is transmitted through spatialised feedback networks (in the PerT mnemonic buffers) and is heard around 21:37. From 22:10 onwards the band-passed filtered vibrated skin noise builds, and fortuitously terminates on the rupture gesture at the end of the playback buffer.

By 25:00 there is a sense of closing. The visually observed bodily gesture and its audible trace are completely decoupled across time. At 25:00 I make scraping gestures on the nay holes, very close to the microphone, but not heard. The intention was to create a disjunctive opacity, rewarding close reflective listening. From around 28:38 these traces are heard clearly as the overall energy dissipates into the background apophenically generated al-Farabi synthetic textures.

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To conclude this discussion of *R | S | E,* it was a key impetus to research mnemonic systems, re-entrant cycles, automated feature extraction and the not-knowing position discussed in Part 1. As trace circulated through mnemonic buffers, automated parametric thresholds changed (controlled by PT averaged pitch and amplitude features). Combined with performer-driven decisions, the RIA-helix was decoupled over various durations, stretching out across time. The sonic surface evolved steadily, generating large-scale form emergently from the initial acoustic material. I think the project succeeded in affording an oneiric listening state, promoting a drifting between listening stances, at times as immersive evental flow, at others as motivated interiorities. By keeping the surface sparse, trace could re-enter quite recognisably, retaining clear semantic legibility. Speaking from an interiority, the nay becomes weary, perhaps saddened by what it witnesses.

6.5 CoP.live

Figure 36: The *CoP.live* system at CBSO Centre, Birmingham, March 2014

Following *R | S | E*, I extended the RIA-modelled structure, rebuilding it in Supercollider as *CoP.live*. This was used in the *Conspirators of Pleasure* improvising trio comprised of me, Poulomi Desai (sitar and electronics), and Simon Underwood (circuit bent devices). We undertook a UK tour (organised by the Usurp Gallery, London), with another trio who performed *Indeterminacy* by John Cage (Cage, 1958/2011 and Taruskin, 2005). That trio comprised Stewart Lee (reader), Tania Cheng and Steve Beresford (both piano and various electronics and objects).

I will not discuss the tour or *Indeterminacy* in any detail, but will touch on *CoP.live*[121] as a bridge to the most recent version of *hQi.live*. The common focus between trios was to engage compositional indeterminacy in distinct ways. In Cage's well-known piece, there is no determined synchrony that semantically links the short stories (which are accessed in random order and each read in the space of one minute), and the accompanying improvisations. This led me to think about chance and stochastic processes, and apophenia as discussed in Chapters 3 and 4.

An image of *CoP.live*, and an overview of the signal flow are shown in Figures 36 and 37. *CoP.live* used a suspended bass daf, and three additional drums (Persian daf, turkman daf and riq) that could be played traditionally, and/or have a speaker transducer and objects placed in them. I placed vibration transducer speakers[122] into the instrumental space, driven by audio signal generated from different mnemonic buffers, which created parallel recirculations through the RIA streams over different time-frames. This gave a more explicit re-entrant coupling of the system's response sound outputs with its reception input stage. To the right is an inverted metal darbuka with a DPA mic and transducer inserted. With the nay, these provided four channels of audio recorded into the four separate memory buffers.

A bank of feature extractors analysed the acoustic sources to generate perceptual feature control streams. Control streams also came from control surface inputs (Softstep 2 and QuNeo haptic MIDI controller) and noise, non-linear and stochastic synths that formed a

[121] None of the material from these shows is submitted as each performance was around sixty minutes.

[122] A surface transducer is placed onto a solid resonant surface to produce a resonance speaker. A variety of commercial models are available.

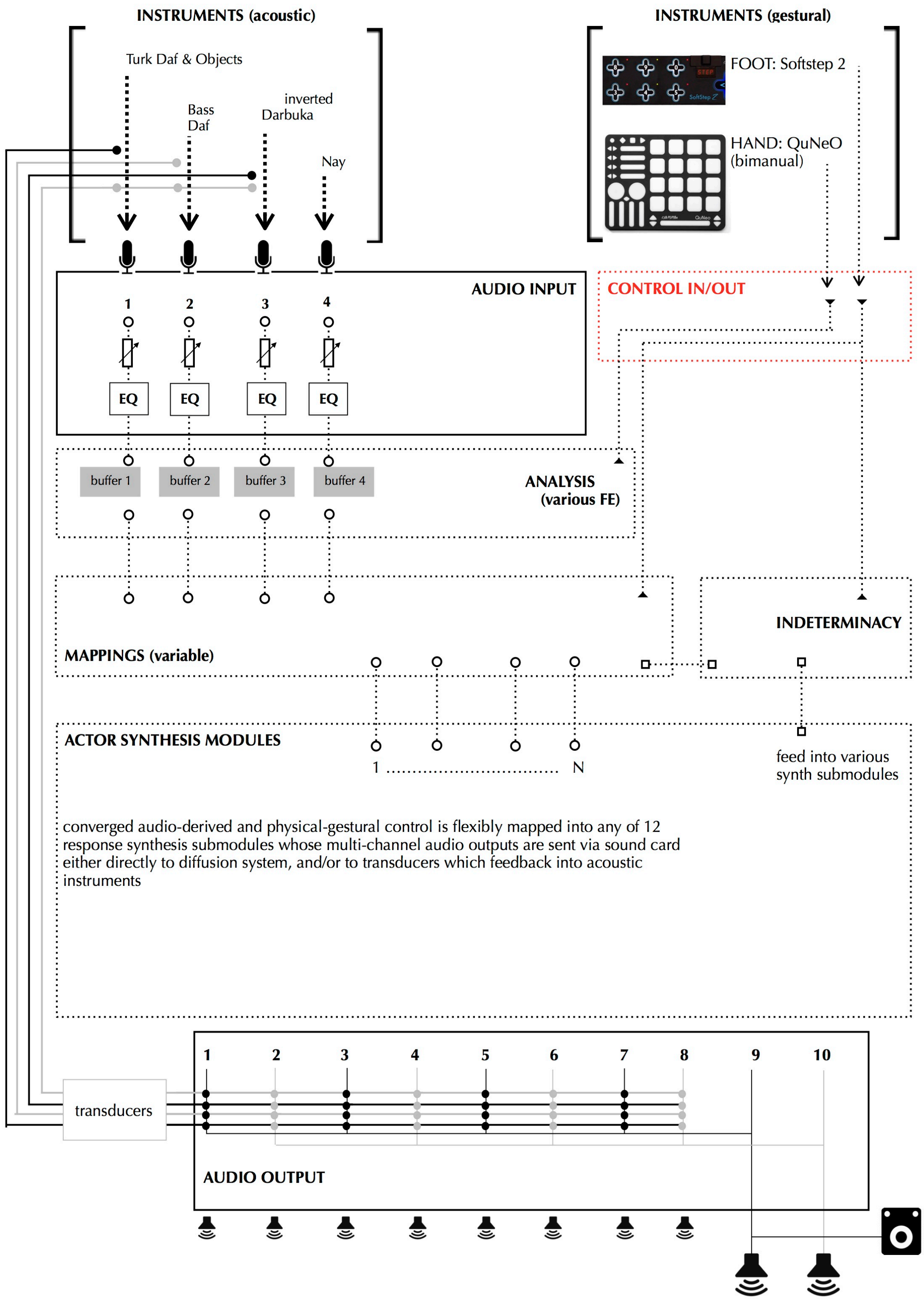

Figure 37: *CoP.live* overview of signal flow

set of indeterminacy modules. The QuNeo is positioned to sit in the same workspace as the acoustic instruments.

Individual control elements are touch sensitive, and afford up to a three-dimensional vectorial space[123]. These were passed through the mapping layer, such that the three control streams could be kept separate or merged in a variety of ways, and passed to the actor synthesis layer to parametise audio outputs to the stereo house system, and to the transducers. The latter allowed sound to be flexibly returned to and acoustically filtered by the instrumental bodies, and manually manipulated before re-entering through the microphones.

Aside from tweaks to the acoustic instrumentation and change of software platform, there were five key developments from *R | S | E*. *CoP.live* had four entirely independent feature analysed acoustic streams. It had more explicit re-entry between system output and input into discrete acoustic spaces that could be performatively intervened into, in continuity with acoustic instrumental techniques. I introduced a range of stochastic, noise and non-linear inderminate control modulators. Fourthly, it had the ability to switch (through changing the mappings in real-time) between manual, feature extracted and indeterminate control signals. Finally, there was merging of control signals to select between multiple audio channels sent to the transducers. A sound source could then be panned across the separate instruments, or voice the different instruments simultaneously.

CoP.live had five multichannel output synthesisers as follows:

1. \GrainRev (developed for *The Remainder)* placed reverberated grains from acoustic inputs out to the transducers, offering interesting rhythmic and textural results.

2. \GlitchMaqam used *maqam bayate* frequency arguments, noise and filters controlled by random walk generators.

[123] For example, a square pad has pressure, X and Y continuous control streams, allowing three parameters to be altered with one finger, increasing their expressivity in performance.

3. \Bayate_Brown_Form also used the bayate, gaussian triggers to output impulses statistically around certain frequencies, and triggered random walk generators to shape formants.

4. \ChaosSynth was a variant of GENDYN, the dynamic stochastic synthesis generator conceived by Iannis Xenakis (1992).

5. \BuzzY used gaussian triggers filtered in parallel by triggered random number generators, and sent noise to the outputs through various spectrally filtered delay lines and reciprocal panning.

❊

CoP.live was successful as a live electroinstrumental system, and under gestural control it offered the agility needed for rapid improvisatory exchange. The flexible output routing allowed a point-source to stereo image expansion and contraction. When sent to a single transducer, the effect was to ventriloquize the receiving instrument, for example a voice filtered through a drum. When the same voice was then also sent to the main house system, a combined stereo image emerged, adding 'punch' to the sound, and the potential to access visceral high-amplitude low-frequency areas (that are filtered out by the instrument).

Contrasting with this rapid and gesturally contingent helix, when dominated by the indeterminacy modules, the system behaved autonomously. I could stand back and allow the processes to take their course. Overall this created a satisfactory tension between my performative intentions and the 'intentions' of the system. I found an optimal balance (much as described by David Huron in Chapter 3) between predictability and novelty. The indeterminacy added a degree of not-knowing such that *CoP.live* felt more like an agentive partner rather than an effects processor or prosthetic performance extension. In fact, it was the experience of finding myself (as performer) displaced and decentred by the system which came to be of interest.

6.6 Dark Geometries

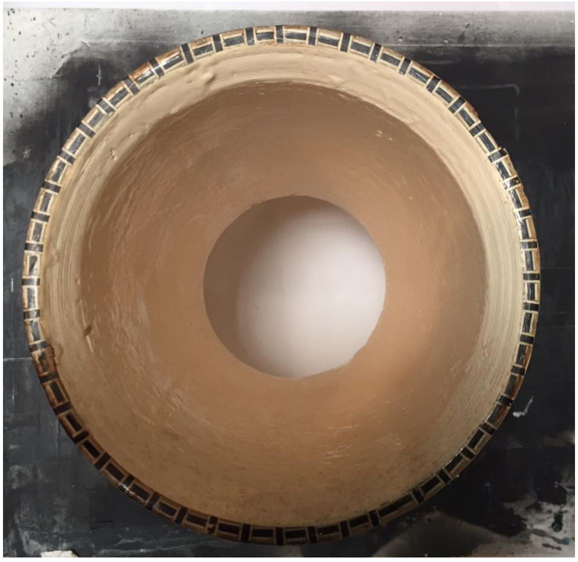

Figure 38: Resonant Object publicity image for *Dark Geometries* (2016)

In Chapter 5, I discussed the fig-2/ICA show and publication of *LTaBoID* that included essays on the themes of Part 1. The concepts of opacity/transparency and the contagion of listening through the geometries of we-centricity led to an invitation to work with a group of visual artists at Coleman Project Space (London, November 2016). The show was called *Dark Geometries*, and was an opportunity to further develop *hQi.live*.

I presented a live performance on the opening night, and the assemblage was left in situ as an autonomous installation playing apophenically with the film *Bloc Haus* by Gill Ord (submitted in the portfolio). The overall signal flow for *hQi.live.DG* was like *CoP.live*, but outputting to a standard quad speaker array. There was no nay, and I made some refinements to the software. Figure 39 gives an overview of the signal flow, to emphasise the RIA-helix, which is mapped in Figure 40. Figure 41 shows the DSP signal flow in Supercollider in more detail.

As I have already outlined the main features in my discussion of *CoP.live*, I focus in the next subsections on four main ways in which *Dark Geometries* was informed by the BPS_paC: the re-entrant standing loop; a strong emphasises on evental flows over interiorities; decentring of the listener-composer PSM; and, apophenic production and perception. This updated version refers to 'agents' in the action layer, consistent with my BPS_paC and discussions on interaction in the EAM literature (Hsu, 2005; Winkler, 2008; Whalley, 2009; Collins, 2011).

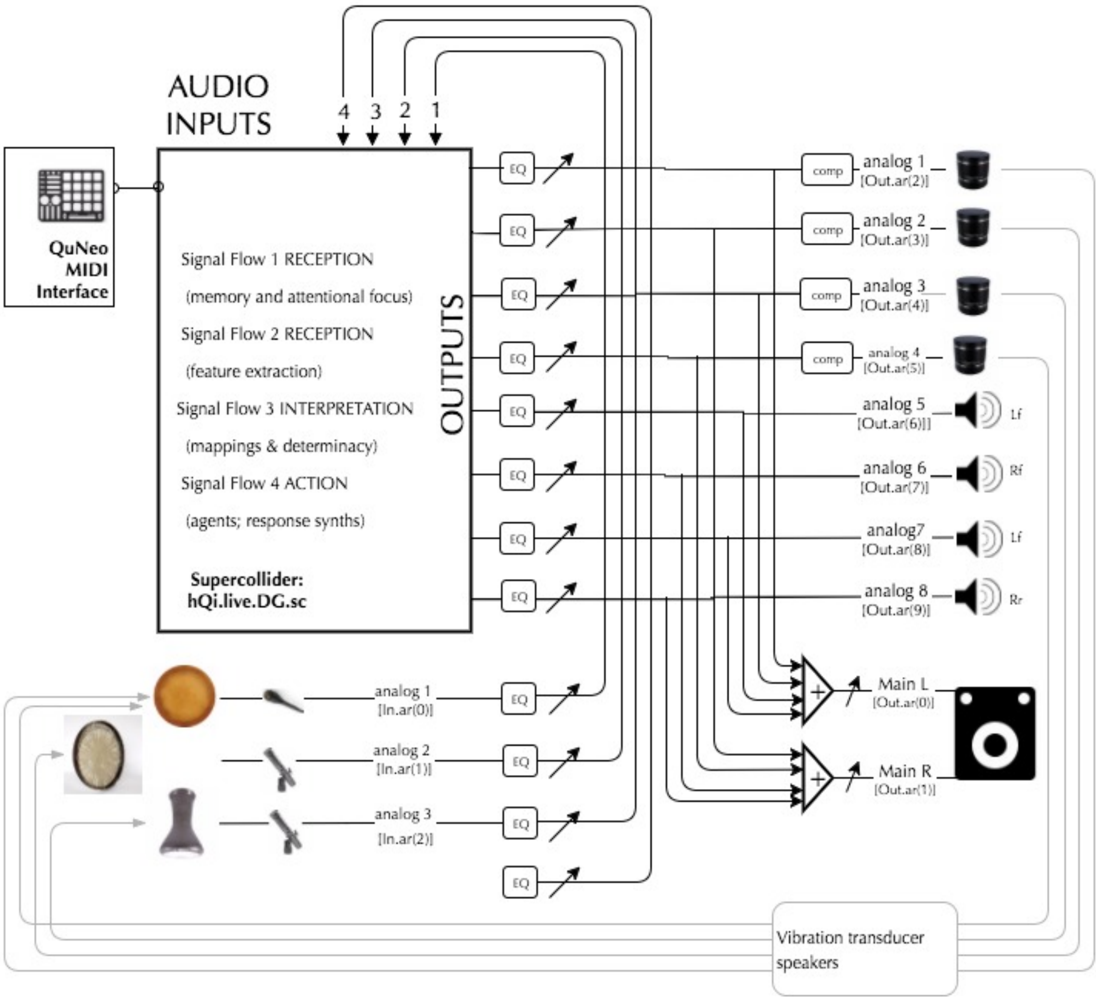

Figure 39: *hQi.live* for *Dark Geometries* overview of signal flow

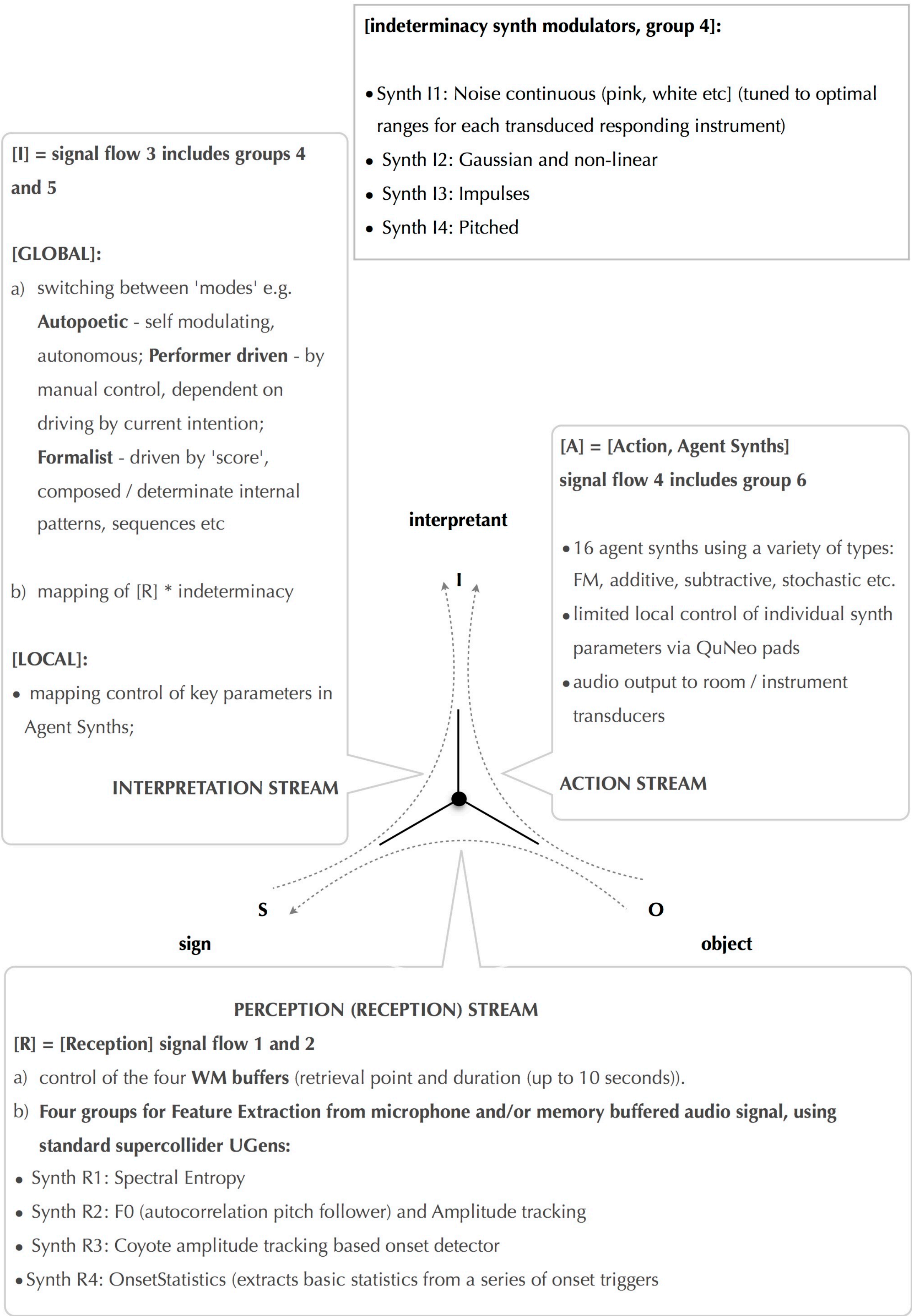

Figure 40: hQi.live Dark Geometries RIA map

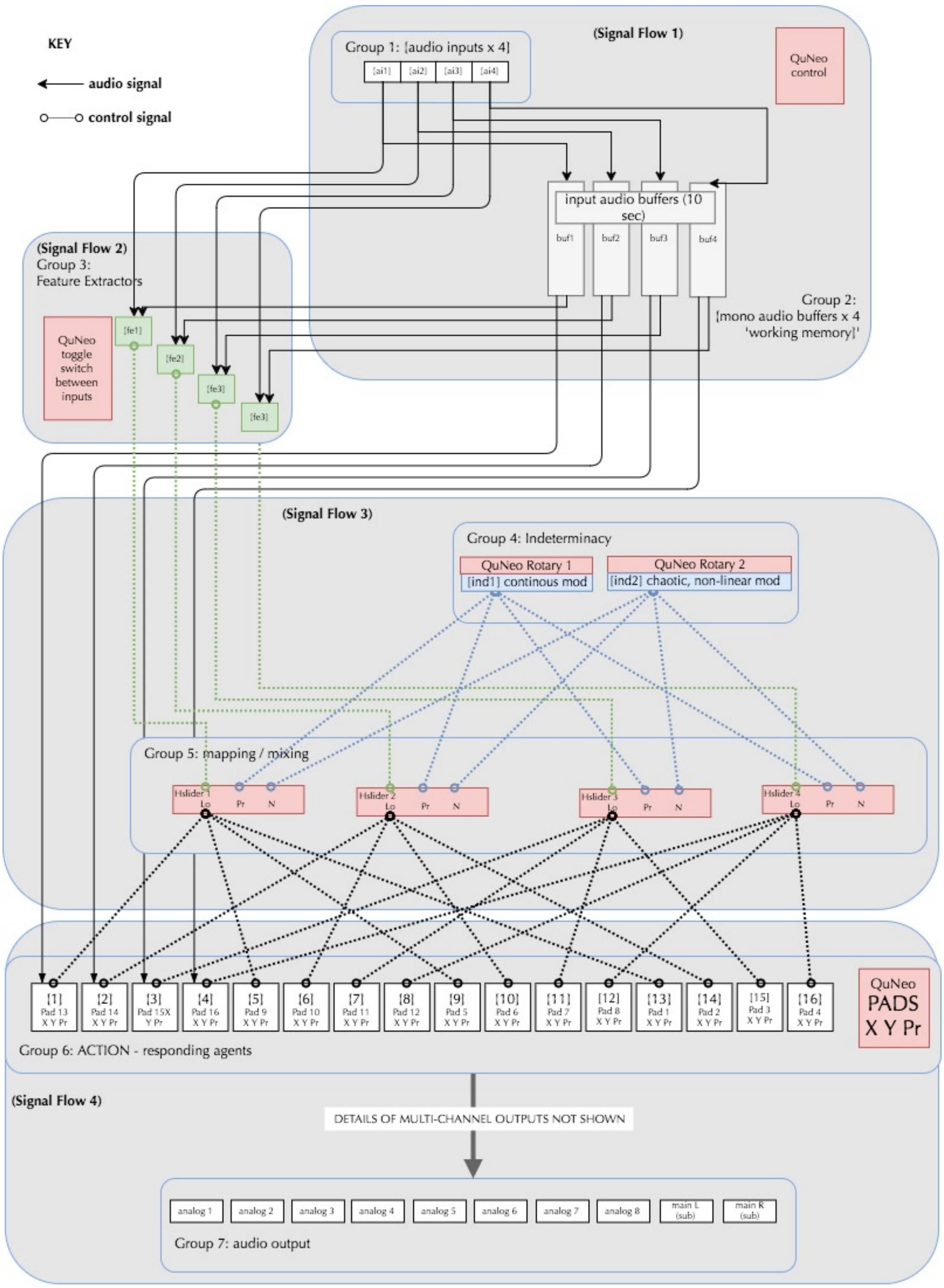

Figure 41: *hQi.live Dark Geometries* signal flow. (fe) feature extraction, (buf) memory buffer

6.6.1 Re-entrant loop and emergence

Compared to *R | S | E*, in this performance the sonic surface changes quite rapidly becoming dense and saturating the room. During performance, I initiated instrumental gestures mostly using various tools (small hand-held motors, tuning forks, and various textured objects) to agitate the drum skins, and manually manipulated the transducer contact with various surfaces, as well as the QuNeo control interface.

The circulation from acoustic sources and room through four DSP signal flow layers and back to instruments and room created the re-entrant loop as a crude modelling of the thalamocortical loops subserving consciousness that were discussed in *Chapter 2*.

In Figure 41, signal flows[124] 1 and 2 constitute the reception stream. The retrieval start point and duration of playback from the four memory buffers were independently set through the control interface. Their temporal ranges could be swept, giving four moving windows of 'now' ranging from 0.1 seconds (within AO manipulation range) up to 10 seconds (just beyond the upper limit of WM). These approximated an idea of attentional focus, perceptual and present trace (see Box 3).

Four groups of machine-listening feature extractors worked independently, switchable between the live and buffered inputs and sending to the mapping layer. This layer also received constrained continuous noise or chaotic non-linear feeds from the indeterminacy module. These two signal flows (FE derived and Indeterminate) merged in the mapping layer as in *CoP.live* (and the live version of *Makharej*).

Each of the four horizontal sliders of the QuNeo (in Figure 41) manually cross-faded between three control streams to the agent synths. This allowed for concurrent modulations that helped bind the audio outputs perceptually from the responding agent synths.

[124] These signal flows relate to grouping that order the synthesis nodes in supercollider. The specific details are not relevant to the main discussion here.

Additional QuNeo controls in the action layer (signal flow 4) allowed me to have control of limited agent synth specific parameters (such as their output volumes, voicing and panning).

Figure 40 shows an explicit mapping to the assemblages RIA helix. The reception stream is comprised of signal flows 1 and 2 and includes audio input, the WM buffers and their manual controls, and the FE synths. The interpretation stream is formed by signal flow 3 and includes the mapping and indeterminacy controls. The former were very simple, using various transfer curves to merge inputs from between FE and the two indeterminacy outputs.

Although Figure 40 indicates a switching between self-organising 'autopoietic mode', manual 'performance mode' and 'formalist mode' (driven by automated score coding), this is more aspirational than successfully achieved. The autopoietic mode takes after Maturana and Varela and has yet to be successfully implemented. The system will work autonomously under the brute force of high-intensity noise, sustaining itself in a kind of positive feedback loop, but work is required for it to operate properly as a self-organising and autonomous system at sparser and low-intensity levels. I am currently looking to develop ideas modelled after Di Scipio's Audible Ecosystemics (Di Scipio, 2005) and intend to refine the FE using current MIR[125] techniques (such as K-means clustering, and machine learning).

The 'formalist mode' is intended to place the three streams under algorithmically scored control and will be pursued at a future date. The performance submitted is therefore operating chiefly in 'performance mode', although it is still largely driven by self-sustaining processes.

The interpretation stream in Figure 40 shows four modulation synths. They are continuous noise (of various kinds), discontinuous stochastic synths (using the supercollider Gendy objects and chaos processes), impulses and pitched continuous synths. In the actual patch (in Figure 41), synth I1 and I4 group into a continuous modulation function, and I2

[125] Music Information Retrieval.

and I3 are chaotic / non-linear / impulses. In the performance, one can hear broadly two sections. The first part is dominated by I1 and 4, and the later section by I2 and 3.

The agent synths used a variety of individually simple standard synthesis techniques (additive, FM, subtractive) and some non-standard mainly Gaussian based noise generators. These could be switched on and off, have manual volume controls, and two timbral parametric dimensions under manual control, but are largely driven by the signal chain exploiting the polymorphous response characteristic of OOP to the same messages. Their outputs spatialise to the sound card sending to the four speakers and transducers.

6.6.2 Evental flow and decentred performer

In *R | S | E*, the evolution of the RIA process was slow, to allow time for extensive DSP processing of the sample-buffers. In *CoP.live*, the emphasis was on the dexterity of the system to allow real-time exchanges with the other performers. I think those conditions promoted a primarily reflective interiority stance.

In this version, while a live performance, I wanted a strong emphasises on exteriorities, of evental flows over interiorities, demonstrating a generative system that had its own agency, and was largely autonomous from my actions. I hope this is apparent in the submitted documentation. The buffers were set to around four seconds at the lower range of present trace, so activity accumulates quite rapidly.

At the very beginning, fireworks outside the venue have been picked up by *hQi.live*, setting up low frequency spatial pulsing, as I am setting various parameters. At 0:46 I open the mic feeds to initiate the automated processes. The short buffering can be heard as pitch-transformed outputs feed the transducers in other drums, rapidly build up to 1:42 where I drop out some of the agents and set longer buffer lengths. There is no acoustic instrumental performance until 1:46 where tuning forks set up spatial echoes. Prior to that I am making small changes to agent synth levels, but the re-entrant helix is behaving largely autonomously.

At around 4:36, human presence (tuning forks) sounds peripheral to the predominant evental activity of two spatialised gaussian-based agent synths inexorably transforming around a rising pitch centre, giving a steady sense of ascending the spectrum. At 6:54 squalling noises mark a shift of spectrum. The ensuing timbral evolution is secondary to my adjusting and switching agents, eventually giving way to manually produced metallic iterations on the body of the metal darbuka. A major change comes at around 17:08 brought about by my shifting the indeterminacy modulation globally from continuous to non-linear where we hear pulsed and rhythmic components. The listener might hear a particular spatial synth that featured in *The Remainder*. The onsets and duration of these gestures is under my manual control and I interact with the autonomous pulsing agents that predominate through to around 19:32. From 21:40 as the density is reducing I am only manipulating transducer positions, bringing about timbral shifts.

The performance was well received and audience members particularly commented on the viscerality of the experience, which I regard as a success. A reflexive-exteriority of immersion, affect and evental flow.

6.6.3 Apophenic production and perception

In Chapters 3 and 4, apophenic mode is discussed, and I use this here in two senses. Firstly, rather like the intrinsic activity of the m-Log, the Indeterminacy modules generated various stochastic and noise-based modulation signal that added significant jitter to the FE tracker outputs. This gave a variable degree of randomness to the outputted audio that had no compositional interiority *per se*; rather this strategy was experimental to find what it would do in the listening. Inevitably, in the light of my Chapter 3 discussion, 'meaning', whether conceptual or non-conceptual, appeared. The two gaussian synths that I mentioned generated much of the higher intensity and stochastic developments and I think produced much of the affective immersion.

Apophenia also operated in a different sense. Gill Ord's film was present at the performance, but could not really be appreciated because the room was full; however, during the installation, I was struck by audience comments regarding the 'close attention to detail, between image and sound' (as one visitor put it). In fact, much like Cage's *Indeterminacy* the sound and image where unsynchronised. The sound repeats approximately every 24 minutes, and the film every five minutes. While there is no an intentional correlation between the two semantically, there is a commonality of affect. *Dark Geometries* explores apophenic perception to see how the changing visual context played out and might recontextualise the listening experience.

6.7 Summary

This chapter discussed some of live work, and included the *m-Log* controller that enhanced the intermediation of reception, interpretation and action as a rapid and fluid triple helix, and which added a degree of stochastic flux rather like intrinsic brain activity (although I do not want to press this analogy too far). The chapter looked at rather different approaches to live work, which both initiated and was informed by my discussions in Part 1, and which lay at different ends of the technological spectrum.

Batroun Concrète took a 'raw' BPS approach to concrete sound and interaction, investigating key ideas that have been discussed, and eschewing the computer-based transformations that now predominate in EAM. The piece particularly investigated not-knowing, and the enactive RIA-helix was explored through structured site-specific improvisation. While it was never fully realised, I think it offers proof of concept and I plan to develop the approach in future site-specific work.

By contrast, the development of *hQi.live* traces my attempts to apply BPS_paC concepts to the post-acousmatic technosocial. The trajectory of this assemblage began with a conventional live sampling and electro-instrumental paradigm, developed to introduce non-contingent indeterminate processes that gave it (the appearance of) a more 'self-determining' set of capabilities and which made it (in my interactions with it as a performer) less of a prosthetic extension and more like an agentive partner.

As a modelling of the BPS components of the human biosystem discussed in *Chapter 3*, *hQi.live* is crude, although good enough to produce (I suggest) interesting work. Looking forwards, the re-entrant processes of *hQi.live* could be much more sophisticated, and perhaps computationally model thalamocortical circuits and working memory systems that approach the human biosystem's. I plan to incorporate work from the rapidly developing fields of music information retrieval, machine learning and artificial intelligence to develop future assemblages. I hope, however, to have demonstrated the potential for further developments which might yield assemblages that cross over from live performance into self-organising autonomous installation works.

My aim here (and in the previous chapter) has been to establish a broad and extensible framework through which to rethink the ground assumptions of authoritative sonic territories. This has arisen out of the diversity of my practices. In this chapter, the focus has been on using electroacoustic means as epistemic tools, in the live work investigating approaches to structural coupling, through forming on-the-fly coherences between materials. Speculating on the body-based cognitive scripts that reside in procedural memory, and to which we have no introspective access brought me up against the limits of language. While I have given a narrative account of my encounter, there is clearly something profoundly missing which I think is clearly present in the accompanying portfolio – the apparent adjacency between what I can say of the experience of sounding, and the sounding-itself. It was this experience which gave rise to the opening section 1.1 and to the distinction between sound and trace.

hQi.live has tried to model aspects of trace, explicitly organising couplings between acoustic instruments, rooms, hardware, and code. I have attempted to explicitly implement some functions of the listening-composing mind in various signal networks, and I feel that with the broad BPS_paC in place, I am now able to develop the depth and detail in future works.

Chapter 7

Conclusions and anticipations

7.1 Making an ending

As I close this thinking and sounding, I should address an apparent oddity. While Part 2 engages specific Islamic and intercultural sociopolitical themes it was not presaged by ethnomusicological or sociocultural theory. The reasons for my trajectory are latent in the influential observations of the musicologist Philip Bohlman:

> […] belief in self-immunity has historically led to a remarkable capacity to imagine music into an object that had nothing to do with political and moral crises (Bohlman, 1993: 414–15).

He had musicology and ethnomusicology in mind, tracing the depoliticising of music as itself a political act of neutering arising from the 'search for the authentic' (ibid: 421). While those disciplines have made great gains in moving away from essentialism, implicit in my position is that some authoritative compositional discourses have yet to do so. The belief in the sovereign composer somehow immune from, outside of and transcendent to her sounding conditions, struck me as a humanist conceit predicated on a 'privileged endowment from which the rest of nature is excluded' (Cox 2011: 146).

I saw parallel problems with the authentic of the Schaefferian acousmatic, the Schaferian acoustic ecological and wider practices predicated upon humanism. As was discussed in Chapter 2, this amounts to something of a crisis for thinking sound, occurring against a backdrop of wider geopolitical crises. While for Schaeffer musical perception originated from a telos in Greek antiquity, from a bioevolutionary perspective, this telos is a great deal more ancient, composed of a variety of subpersonal, interpersonal and suprapersonal processes.

At root, listening is a covert behavior geared towards placing us in an eventful world, and to acting in this world. Visceral trace erupts relatively unbidden through a constant background thalamic scanning for potential salience and threat. Sound gets affectively into us and throws us towards reaction prior to its construction in thought. Thoughts about these traces are cortically integrated, filtering impulses and interposing to decouple automated linkages between perceptions and actions. However, attentive listening did not arise to simply avoid being eaten. Rather, as social primates, the human listening-mind evolved to deal with uncertainty and other minds. Our capacities for musicking stem from group affect regulation, social cohesion, in-group/out-group tensions, warfare, narrating our place in a mystifying world, and to establish joint intentionality and coherence. As such, I think musicking is inextricably linked to the sociopolitical.

As I observed in section 3.1.3, the ear, mind and socio-political interpenetrate, hence to compose is to think the trace of sound as linked to '[…] the messy and political human sphere' (Sterne, 2003: 13). To exert its effects, it is drawn to 'conflict, uncertainty, or stress within the social fabric' (McLeod, 1974: 113, after Cross, 2015). This is not to say that all composers must have a (broadly) political engagement, but often they do, myself included. As I have already observed, every discourse about sound (including mine) is tied to a world-view.

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The approach proposed here, offers a framework in which both listening-subjects and sounding-objects are on equal terms, both emergent from matter-themselves. Phenomenological experience, and sounding worlds become things to be accounted for within the same conceptual 'game space' as Negarestani put it.

It is through my sonic practices discussed in Part 2, that the discursive territories of sound became most apparent to me. By dealing with the specificities of my encounters with the Islamic sonic-social I came to explicate what I saw as inadequacies in traditional acousmatic and soundscape approaches. To resect perceptual essences away from the ramified contexts and provenance of my field recordings, or to approach them as exotic soundmarks was inadequate to engaging their sociopolitical resonances. It risked either aculturally deracinating and reducing these traces, neutering their specificities and bracketing out their shades of meaning, or else potentially idealising them as markers of alterity. From my art-activist orientation, applying either framework potentially colonised these sounds. For someone interested in the 'structuring of the aesthetic as an act of political force' (Mackay et al., 2014: 3) this was unacceptable.

I was unwilling to play the 'participant observer' or 'informant' and set off on reflexively (in the humanities sense) locating my practice within complex webs of determinations and mediations that construct identity, interculturality, globalisation, authenticity and so on. This is not to deny that such issues are relevant, but I did not want to confine my approach to such considerations, instead setting my thinking on foundational problems with theory. I sought an outside trajectory that might connect to broader, even universal questions, and to find a suitably extensible but none-the-less secure basis from which to think sound and sound thinking. That is not to say that scientific discourses are somehow culturally or politically neutral, but that is a matter for elsewhere.

By acknowledging at the very outset that we are immersed in an ocean of global sound, and by extension that post-acousmatic composition is an international activity, I wanted to make a contribution to grounding discourse in general claims that may be tested, contested, revised and reformulated through evidence and interdisciplinarity. More specifically, I think that such theory should seek to not be culture-bound and should place the social and cultural into a broader frame.

7.1 Evaluation and future trajectories

I have made a basic distinction in this writing between thinking sound and sounding thinking. The former is discourse about sound, how systems of linguisticity construct territories for sound at the cultural level. The latter, is sonic thinking - what Cox (2016) calls 'sonic philosophy' - which compositionally deploys trace, working to generate a sonic surface, organising sound as a form of thinking. While this has an overlapping adjacency to linguistic discourse, critically it deploys non-conceptual musicogenic meanings and sonic-evoked affects to form effects on the listener.

Beyond the BPS systems that are required for the experience of sound and music, I have taken a particular position, arguing that a post-acousmatic composition might take an art-activitist stance as a form of critical practice concerned with disrupting habitual aesthetic regimens, aimed at prompting reflection on normative listening habitus through defamiliarising the phenomenal contents of auditive introspection.

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In this research, I hope to have avoided 'weak collage' and to have presented a convincing argument for, and a path towards, exiting authoritative sonic discourses (Stafford, 2008: 5). I have proposed 'deep forms' to organise thinking sound away from the simply discursive, by proposing an 'alloy' of compositional thought with insights leveraged from a variety of scientific disciplines (Polansky, 1990: 385).

Given my aim, the approach is necessarily interdisciplinary, inherent within which are methodological and discursive problems. My background in psychiatry means that I am concerned with evidentially evaluating research claims, often by recourse to quantitative systematic meta-analysis, and detailed critique of experimental methods. Very little of that is evident in the writing, principally because these epistemic methods are not really germane to compositional scholarly approaches. Such an approach applied to music would indeed be 'cognitive musicology' (or perhaps a systematic neuromusicology) (Di Scipio, 1995: 370–1). However, I suggest that the findings from such approaches do usefully contribute to rethinking sounding.

I think this is a difference in orientation to questioning and thinking. Typically, composers co-opt interesting ideas as points of departure for practice. They are usually unencumbered by evaluating ground truths and construct validity. What matters is how their adopted concepts play out pragmatically in the generation of new works. This has resonance with psychoanalysis, where personal truth (what Bion (1965) referred to as 'O') is a shifting presence that emerges in the dyadic relationship. It often cannot be known with certainty, or rather is salient chiefly by the turbulence that come in its wake. For me, there is a close affinity to improvisation where exchange is negotiated, regulated back and forth, from which something not-known might usefully emerge.

The interdisciplinary difficulty in forging a science and art alloy is often discussed in terms of C. P. Snow's well known two cultures (Snow, 1959). The one is concerned with objective, third-person accounts that seek tractable hypotheses, predict observations, build evidentially refutable theories and are often concerned with formalising quotidian general processes (although of course the exceptional often provides insight into these). The other is said to be concerned with specific hermeneutic tropes, with discursive argument and so on. Snow famously concluded that:

> […] the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their Neolithic ancestors would have had. (Editorial, 2009)

I do not mean to imply that composers and sound theorists are such Neanderthals, but I do think that adherence to the articles of faith of authoritative discourse, in the context of the ongoing cognitive revolution has something of that about it. Fortunately, either Snow was incorrect, or else the situation has now greatly improved. There is much common cause and confluence of interest between arts and sciences disciplines, with mutual recognition of creativity and inquiring practices. I do think, however, that useful distinctions remain. For me, as a practitioner of both worlds, the difference is in their goals. The scientific seeks new epistemic things to ground thought and explanatory frameworks in the materially real that lays beyond and which constructs us. The artistic seeks to capture and harness forces that form a singularity, a new epistemic thing in its compelling irreducible specificity. I hope to have harnessed insights from both, and to have suggested a secure but plastic and contestable framework that might usefully contribute to a regrounding of sonic discourse.

At the very close of this writing *The Order of Sounds* by Francois Bonnet (2016) was published. I have yet to give it the attention it deserves, but I was gratified to see his emphasis on trace which mirrors the approach that I have developed. Perhaps there is something in the *zeitgeist*, which I think emphasises that none of us are sovereign beings but rather, are subject to the anonymous flows and shaped by biopsychosocial processes.

Reflecting on this writing and on the portfolio, how might these contributions to knowledge be evaluated? What are the implications for future work? A chief consideration in evaluating an interdisciplinary thesis is the degree to which, firstly it is actually interdisciplinary in its scope and execution, and secondly, that it potentially makes contributions to knowledge across scholarly domains. On the first point, I think the research succeeds in critically engaging methods and findings from a range of related disciplines: chiefly, the biopsychosocial medical paradigm, cognitive and auditory neurosciences, psychoanalysis and mentalization theory, anthropology and sociology of science, philosophy, electroacoustic compositional theory, and implementation using largely object-oriented programing environments. On the second point, I think the various models that I have drawn together under the rubric of a biopsychosocial approach to post-acousmatic composition have implications for theory and practice in a number of areas.

I suggest that there are three key aspects to consider, which I shall approach in turn. Firstly, I shall return to Part 1 and the theoretical philosophic-compositional questions raised at the end of Chapter 2, and summarise the insights from the BPS approach. Secondly, in Part 2 I made claims to have applied the BPS paradigm to my compositional work. I shall consider the 'knowledge-level strategies' that have arisen. Finally, I shall present some closing thoughts.

7.2.1 Summary of a post-acousmatic biopsychosocial approach

I began with vying perspectives and claims about the nature and power of sound, and argued that the authoritative discourses predicated on human phenomenality have led to powerful forms of magical thinking, believing themselves to speak from sounds-themselves.

Pierre Schaeffer has been a main foil for my argument. This is not, however, to discredit the rich and varied lineages of practices that were set into motion by welcoming any sound into the scope of compositional practices. Nor is it even to reject a focus on what we have of the experience of listening to sound. By understanding his strong objections to Xenakis, and clarifying his position on 'authentic musical perception' it has been possible to proceed from a key flaw in the extant acousmatic. Along with Kim-Cohen and Kane, I have rejected Husserlian phenomenological approaches as ahistoric and acultural, implausibly conflating technique and nature.

Schaeffer's rambling verbosity, contradictions and absence of any true explication are oft cited as a key difficulty for theory (Palombini, 2001). However, in its positive valence, this is testimony to the provisional and difficult nature of thinking sound. Schaeffer, like all of us, was a product of his biopsychosocial conditions. I have drawn on a number of sources to highlight that the acousmatic is better understood as a stance which is first and foremost epistemic – it is a question of not-knowing.

Schaeffer is perhaps not the worst offender in overcoding the sonic by the discursive. Another is exemplified by Murray Schafer. I have contested that soundscape approaches have also been hampered by a predication on the humanist 'manifest image' (Sellars, 1962, after Mackay *et al.*, 2014: 5). My objection has been that acoustic ecology tends towards an anti-technological preservationism which constructs romanticised notions of place and is at root regressive in that, it too insists on the 'special endowment' of the human, anthropomorphically retuning the world in its own image (Cox, 2011: 146).

Perhaps I should clarify. I raise no objection to close introspective scrutiny of auditive experience in its variegated forms, or to desires to appreciate the specificities of sounding locations and environments. The difficulty is what we claim for those experiences. We never have direct access to sounds-themselves in experience, although we can access this real technoscientifically. While they impinge upon, immerse and even saturate us, they are temporal, ephemeral, always decaying, and withdrawing from our capacities to apprehend them. All we have of sounds are the traces that they leave. Inevitably, in order to communicate about sound, trace proliferates through language and is both enriched and constrained by discourse. The key problem is how the discursive orients itself to its object.

In its positive valence, it sharpens our perceptions, inferences, thinking and composition of trace. In its negative valence, it disciplines and constrains sound, believing itself to speak for sounds-themselves through treacherous notions such as authenticities and essences. However, even this is not the problem *per se*. The discursive can speculate and make claims in whatever way it will. The difficulty is when it believes that there is no outside, that sound exists only within discursive terms. The limitations and relative narrowness of thinking sound in terms of these humanist and idealist suppositions and horizons is revealed in the face of varied and complex contemporary musical practices that it struggles to both account for and to augment. Extent soundscape and acousmatic theory seem inadequate to this diversity, amounting to a pressing need to exit such authoritative discourses in both theory and practice. I suspect that this ossification of thinking sound is a major cause of the 'over-formulaic' that the judges of the Prix Ars Electronica commented upon.

While the early years of these practices and discourses generated a proliferation of diverse practices and orientations to sounding, I think theory has remained somewhat static and even resistant to developments outside of its own horizons. The difficulty, as I see it, is the way in which we then make claims for sound, or more specifically, the way in which these authoritative discourses have become institutionally calcified as necessarily grounding compositional practices, disciplining what it might be, do or how it might act in the world. In my response, I hope to have proposed a secure grounding for a post-acousmatic compositional theory in terms of its constitutive biopsychosocial conditions, indicating the potential scope and depth of such an approach to composition.

I have argued that sonic thinking has been paradoxically shackled into obedience through a premature knowing of what 'authentic musical perception' is, potentially limiting listening habitus and compositional praxis to normative aesthetic regimens and illusions.

Humanist philosophical positions constrain fantasy and the possibilities for the sonic not - known, and rather depressingly preconceives engagement with the notion that things could be radically otherwise.

The akaousmatikoi were prepared to accept the acousmata without further question, in contrast with the mathematikoi, who demanded argument and demonstration (Thesleff, 2016). Steve Connor links this difference to questions of practice. Whereas the akaousmatikoi:

> […] proclaim the sacralising, preservative or enlarging qualities of sound itself, along with the enlivening powers of listening over the deadening dominance of abstract visualism. The mathematikoi recoil from this kind of credulity, asserting that sound and hearing are not events of ontology, but rather precipitations of historical practice (Connor 2015: 8-9).

To extend from Connor's mathematikoi, I would say that post-acousmatic composition is a precipitation of biopsychosocial processes, historical practices included. With respect to the role of listening, these two positions have indicated different ways to conceive compositional activity. This was evident in the debate between Schaeffer and Xenakis and in the later stand-off between sonic materialism and its opponents exemplified in the tension between Kim-Cohen and Cox.

As I discussed in Chapter 2, post-Kantian humanist thought, Schaeffer's Husserlianism included, is now charged with philosophical correlationism – of being predicated on an unbridgeable adjacency between phenomena and noumena, between self and other, subject and object, thought and being. My argument has been to look outside towards materialist and empirically tractable disciplines. I hope to have convincingly outlined the basis of such an approach by drawing on the BPS paradigm which regards the biological, psychological and social as intermodulating systems. I have elaborated a set of principles, models and key concepts that might constitute a BPS_paC. These are chiefly the eliminativist account of the listener-sound relation; domains and dimensions of the K-matrix; model-based reasoning through a RIA-helix; mentalizing listening stances based upon dual-process cognition models; assemblage and heterogeneous engineering; and, the disruption of aesthetic regimens by bringing the habits of listening into attentional focus. These models are rather nascent here, leaving a great deal for further development. It is perhaps reassuring, that many of the key findings outlined in these BPS models are already familiar from music scholarship. One might therefore argue that there is no need for the BPS paradigm at all. However, I would counter by saying that it does useful work.

Pursuing the theme of interdisciplinarity, I think that this BPS approach might provide a useful analytic framework upon which EAM musicology might build. More broadly, it has application to fields such evidence-based music therapies, particularly the mentalization framework. It is well-known that the choices of musics that we value, which we are powerfully attached to, and to which we return, especially at difficult times of crisis, provides a powerful means by which we make sense of ourselves and others. As such, music can be used as a therapeutic means to bring mentalization into focus. It would be possible for others to critique and build upon the provisional framework outlined here. Music can implicitly embody intense affective states, and powerful personal significances. Making these states more explicit, by using music as a mental state probe could find applicability where listeners might struggle to articulate these states – such as in adolescence, affective disorders, perhaps developmental disorders (such as autism) or personality disorders. I suspect that for all of us, there are times where our mentalizing collapses, music implicitly induces feeling-states that are perhaps too difficult to make explicit sense of, and the framework I have suggested might offer dimensions along which it can be thought through.

In this context, I think the BPS_paC can usefully arbitrate and constrain compositional discourse and the 'powerful forms of magical thinking' that Connor (2015: 9) observed to drive some sound studies.

7.2.2 Rethinking sound: the proposal for a post-acousmatic biopsychosocial composition

The compositional debates of Chapter 2 led to a set of related questions which have been addressed throughout this research.

1. How might a BPS_paC think the listener-subject and music-object relation? Does a 'geometric vectorial relation between subjects and eruptive objects on the same plane' mean anything beyond colourful metaphors?

I offered a philosophically eliminativist and neuroscientifically grounded account of a listener-composer biosystem that models a (soundful) world and a listening self in that world, arguing that both are virtual representations which strictly only exist in the spatiotemporal operations of a suitably functioning central nervous system. The listener-composer PSM is emergent within the biosystem. It is, however, in contact with a material context which is also social and it teleofunctionally operates on that world (as well as being formed by it). It is through the capacity to causally pulsate out into the interaction space of the world that auditory (and other) perception is linked to goals, to actions, to consequences. Hearing is a background monitoring of the auditory scene the operations of which are (under normal conditions) transparent to the listener-PSM. The compositional structuring of trace may present opacities to listening by producing contextually anomalous / salient features that attract the CEN, recruiting cognitive resource which promotes reflective function. This is the core of my proposal that post-acousmatic composition is the assemblage of networks of causal interaction which may be more-or-less adequate to the demands of neurocomputational dynamics, to generate new model-based knowledge which has the rendering of cognitive opacity as a central practice that provokes reflective mental processes.

Cognition may then proceed in its distributed interactions with objects that themselves have certain capacities and limitations, properties that afford interactions which couple in a variety of ways. This is perhaps most directly explored in *Batroun Concrète*. It is through these interactional structural couplings that the biosystem changes its internal structures, and co-creates the appearance (for itself) of a world and a self. Within that world are agencies whose states we can index (both as semantic signs, but prior to that as pre-semiotic contagious gestures). By considering the operations of mirror-neuronal assemblies, and large-scale brain networks I have shown that we exchange with other social agencies constituting a shared we-centricity. The exchanges do indeed exhibit geometric relations as complementary 'extensions of the same correlative and reversible we-centric space [...] a dynamic system governed by reversible rules (Gallese, 2003: 525).

2. Is auditory perception equivalent to the Schaefferian account? Does music have semiotic or semantic properties? What is the nature and function of mnemonic trace? Is the reception and composition of sonic arts necessarily circumscribed by systems of representation, linguisticity and discourse? Do we access sonic realities beyond how we might represent, know, speak of, or assign significance to them? Is there validity to thinking events, affects, flows and so on, anonymously outside of a subject that experiences?

I have considered these issues extensively in Part 1. In brief, auditory objects do indeed share features reminiscent of objets sonore, in that they are the fundamental perceptual units that arise as synthetic act of consciousness (although they are not volitional acts). Their characteristics (as elaborated in Box 2) are, however, significantly divergent from Schaeffer's conception. Rather than perceptual essences, they are primarily tools of consciousness, future-oriented perceptual-inferential models which are cognitive, affective, and convey motoric impulse towards action arising from the saliences of sound in context. Thus, audible trace arises at the convergence of centripetally trajecting material events encoded in spectrotemporal topology, its capture by perceptual-inferential neural machinations and its expansion through centrifugal processes. These centrally originating apophenic processes decouple the AO from an obligation to represent the real and form the basis of auditory imagination, and under certain circumstances become true auditory hallucination.

I am doubtful that we can meaningfully speak of sound outside of an experiencing subject, but of course, that depends on what we mean by a subject. While there is evidence that sound is registered even by humans in comas (who I suggest cannot really be said to be experiencing these sounds), a perceiver is integral to what we mean by sound (as discussed in the *Relational Event View*). That said, I see no reason to circumscribe sonic practices by conscious representational systems, as a great deal is registered affectively, interoceptively and outside of auditive awareness. Indeed, one of the most specific effects of sound on human biosystems are the non-conceptual musicogenic aspects that operate through sonic contagion. Thus, I do think we can meaningfully speak of sonic affects, and implicitly mentalized evental flows as exteriorities which are relatively autonomous from a consciously cognizing listener (i.e. listener in X-E stance). Equally, it is correct to speak of linguisticity as limiting what we can communicate about sound, although not the experience of sound.

Perhaps this might be taken as a return to a modernist search for universals, or even to a pre-Kantian pre-reflexive moment. I do have sympathy for a search for fundamental ground truths, but am keenly aware of, and suspicious of universalizing claims for musicking. If the 'anarcho-realism' of post-modernist thought has value, I think it is primarily because of its suspicion of master narratives (Malik, 2013). It had room for a plurality of perspectives and recognized that (as narrative prone hominids) we construct ourselves through linguisticity. However, we are constructed by evental flows beyond us, and to presume that thinking sound is a question of linguistic games is very much mistaken. While what we can say of our experience of sound is certainly curtailed by what we can verbalise, and to an extent, what we can think sonically is also a function of language-like processes, I hope to have convincingly shown that 'linguisticity is [not] the order that obtains' (to invert Kim-Cohen, 2009: 112, after Cox, ibid).

I have summarized key evidence that supports my assertion that what we have of sound is best considered as trace. This derives from both compositional theory (primarily Xenakis and Brün) and from auditory neuroscience. Trace is what we retain of acoustic vibratory causal material events in spatiotemporal continuity with memory systems, whose saliences mark us as representations. It has visceral (felt-sensation) and cochleal (perceived spectrotemporal) components. I have suggested that there are four key varieties (based upon different functional memory systems): perceptual, (operating over milliseconds) procedural, semantic and episodic (operating over a life time).

Some trace is inaccessible to introspective self-awareness and to language. Its effects remain transparent to cognition. I broadly divided trace into visceral and cochleal, the former reliant on somatic interoception linked to affect and automaticity, while the latter are linked to sound as a conscious perceptible. The latter chiefly forms from a spectrotemporal plane on the ascent to the auditory cortices which can cross over into symbolic discursive territories. Cochleal trace inevitably becomes entwined with language, but this only partially captures the effects that sound has upon us.

I suggested that rather than relying on authoritative discourses, a more robust basis upon which to make conceptual segmentations of listening is offered by considering underlying neurophysiological processes. I introduced Stephan Koelsch's work to suggest the K-matrix as a basis for discrete but interwoven domains and dimensions for musicking. In particular, I focused upon perceptual, semantic, syntactic, action, social (including spiritual) and emotional domains.

Cognitive sciences clearly image an overlapping adjacency between auditory-musical and language neural architectures. The two form communicative systems with differing degrees of spectrotemporal resolution, which likely stemmed from a common progenitor which bifurcated, one with symbolic and propositional specificity, the other optimised for affect and non-verbal gestural contagion (Mithen, 2006; Patel, 2008). Our capacities to think sound arose as a steadily (evolutionarily, historically, culturally) elaborated interposition between automated perceptual event detection and contingent action responses. A similar bipolarity is evident in the dual-process architectures of large-scale brain networks that subserve and characterise musical and social cognition.

3. What might constitute an interiority/exteriority distinction? Is it simply a matter of how different authors choose to define it?

I suggested that biological structures sit at the base of the compositional debates discussed in Chapter 2, particularly the division between interiority and exteriority. Both Seth Kim-Cohen and Christoph Cox articulate distinct vertices on the limits and constitutive conditions of compositional practices. My position has been that both have merit. This is not a matter of seeking conciliatory ground. The best evidence as we currently have it, which sits outside of hermeneutic discussion, is that this dualism appears to capture two basic orientations to sounding. One is geared to a shared externally-focused cognition that appraises the sensed material and eventful world. Connected to this, is our predilection towards attributing intentions, meanings, motivations, desires, mental states and the like. This formed the basis for what I described as systems of interiority and exteriority which we ascribe to sound. Broadly, thinking sound is to mentalize sound, to be able to attend to it as an agentive social other, in the same way that we do with human conspecifics. This affords a connecting of thoughts and feelings with events, and gives rise to musics 'aboutness' – that is, it is both evental flow that lays beyond a self-modelling listening subject, and also it is potentially a signifying, intending other. I suggest therefore that a subject is a necessary component for there to be music, or sound-art, although we may de-emphasis and decentre subjectivity in compositional practice.

Interiority tends towards Kim-Cohen's linguisticity, to discursive networks and formations, whereas exteriority tends towards Cox's evental captures, flows which exert immersive and affective effects. The exact ramifications of an I – E distinction which is 'orthogonal to and cuts across self and other processing' (Lieberman, 2007: 279) has yet to be worked through. What is clear is that it is a robust finding that undercuts the correlationalist divide. Speculatively, I suspect that this underpins the long-held intuition that there is something very peculiar and special about musicking's capacity to permeate us affectively and involuntarily; to occupy a place that seems so intimately interior, so profoundly attuned to states that language struggles to convey. I think this underpins what in section 3.4.1 Ian Cross called music's 'floating intentionality'. In this sense, I find composing a compelling activity that affords the utterance of only partially accessible sonic oneiric states, that assembles perceptual-cognitive-affective-social probes which operate as mental state attractors that pass across and between listeners, musics and composers.

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The most salient question for a practice-based research is the applicability to composition. How might we evaluate this contribution? Given the proliferated taxonomies of EAM listening that I raised at the beginning, is this yet another modelling of listening that territorializes sounding and thinking sound? The answer is inevitably yes. Every communication about sound constructs a territory. However, in my defence I suggest that I have taken a distinctive trajectory. Rather than differentiating new phenomenological species of listening, I have disqualified an over-reliance and over-coding of sound based on the appearances of experience, instead suggesting four fundamental mentalizing poles of XCIE processes.

I have sought to account for human auditive capacities, and by extension practices that organise those capacities into activated figurations, outside of phenomenological contents. This is not to disqualify the actual experience of sound and its traces, but rather to seek a clarifying reduction in the discourses that communicate this experience. Listening and composing are as much questions of matter-themselves as the sonic events they seek to capture and deploy and I have taken steps to place them on equal ontological terms.

In sketching this provisional method, my focus has proceeded largely from the nervous system 'up' the BPS natural systems, but this is only one trajectory through the richly ramified material complicities from which composition emerges. There is a great deal to develop in characterising activities within biopsychological systems with respect to electroacoustic practices, and I indicated some speculative applications in section 4.4. Even within the terms of the account given here, there is a great deal more to derive.

Perhaps most fundamentally, I now think I may have fallen into a conceptual trap. I have treated listening as a discrete sensory modality, when in fact it always exists in a multi-sensory context. Contemporary neuroscience is focusing on cross-sensory modulations, and listening will be greatly inflected by other sensorial cues. We are accustomed to speaking of five special senses, which is not the case. In Chapter 3, when discussing the sonic surface, I introduced interoception (which is distinct from other special senses) but there are others such as proprioception and kinoception. In my visceral – cochleal distinction I have registered that listening is not simply about the auditory, but there is more to do in that area, especially given that much contemporary composition now engages other media sensory channels.

There are differing accounts of consciousness that could inform the listener-sound relation. The ecological validity of applying the K-matrix to EAM is an open question. Does EAM conform to general music neurocognitive models? How might it exceed or dissent from music in general? Might it act as a foil to critique such approaches?

Many aspects of the K-matrix have been left undeveloped. For example, I glossed the account of action and its linkage with perception. Enactive paradigms are widely applied in EAM, and Erik Clark (2005) has successfully and influentially applied the perception-action cycle as a musicological analytic. Might a BPS-informed account of neurocognitive processes enhance these? The action domain of the K-matrix describes nuanced reciprocal feedbacks and error-correction loops between expected and actual sensory consequences of both the motoric and the auditive. Such models could usefully inform electroinstrumental performance studies, or elaborate design principles for performance ecologies and installations.

I have said little about emotion-principles and aesthetics. For example, the nested inverted U-curves of familiarity-novelty in David Huron's (2006) ITPRA model, or Juslin and Västfjäll's (2008) six-component model of emotions both offer models that could be applied to the nebulous area of decision making, Xenakis's 'epiphenomenon', by which we intuit choices when faced with the immense possibility space of technologically enhanced composition.

The RIA-helix could offer a way of modelling improvisation, studio-based composition and audience reception through detailed consideration of the interacting streams, the various components that contribute to these and their temporal organisation through both reflexive and reflective, internally and externally focused cognition. Composition as modelling could be further researched along these lines. Composition models that remain influential in EAM, such as John Sloboda's (1988) rule-based linear approach, or Simon Emmerson's (1989) iterative generate-test approach could be re-evaluated through application of both RIA-helix and the K-matrix.

I may have given the impression that mentalization is a fairly unitary process. Beyond the X C I E are other dimensions (Liljenfors and Lundh, 2015). Development of the dynamical movement within social cognitive poles would enhance an account of listening stances and mentalizing music. There is great scope to consider these stances through detailed case studies, such as between musicants in an ensemble, audiences and performers, composers and music as a social agent, or performers and performance ecologies. The capacity to mentalize has been operationally defined and is measurable. Developing a dimensional metric characterising these stances might help to design better models of musicking, useful to a cognitive musicology, but also to compositional theory if we are able to better understand imaginative processes and target these through practice.

Listening stances could be comprehensively applied to the many EAM listening taxonomies as a way of grouping and refining them, not in terms of their phenomenological appearances, but in terms of their BPS organisation. More broadly the full implications of the underlying X C I E cognition systems have yet to be worked through, especially the I-E relation.

The account sketched of the relations between gesture, music and language could be extensively developed, again away from the simply discursive. I can imagine a continuum from the most elemental empathically resonant pre-semiotic gestural exteriority; their dance organised and combined in various ways into Peircean models and interiorities and exteriorities that might bifurcate. One branch would be linguistic, traces whose proliferation into discursive networks, and cultural systems of meaning could be extensively and explicitly detailed in particular cases. The other branch might develop exteriorities, perhaps taking a cue from Augoyard and Torgue's (2005) elaborated and explicit descriptions of relatively subjectless sonic states.

I would like to see the specific claims that I have made for a BPS_paC, and EAM generally tested. The BPS_paC is derived from general scientific accounts of music. Is this appropriate? Do the implications of these theories of music apply to EAM? They are tractable to neurophysiological and neuroimaging techniques, although whether funding resource would be accessible for such a project is a question.

Finally, much music neuroscience tends towards quotidian musical genres. EAM practically investigates the outer reaches of listening and sounding; hence it could provide very interesting cognitive probes that could be used to test scientific models. Overall I see the BPS as a rich alloy that could mutually benefit both artistic and scientific practices.

7.2.3 Knowledge-level strategies for a biopsychosocial post-acousmatic composition

Have the compositions implemented and responded to the approach outlined in Part 1 of this writing? I think this is an open question, chiefly because I am circumspect about what composers can communicate about their working methods and the actuality of their processes. While I discussed the interconnectedness of my parallel thinking sound and sounding thinking, and find close connection between the two, it is also quite possible that processes critical to how the compositions formed remain transparent to my introspection. As I have tried to capture, music is a hugely complex activity, and its composition multiply determined. The development of the eliminativist model of the listener, understanding both subject and object within a single space was helpful to understanding the possibility of both preserving something of the experience of listening, without invoking a transcendent claim for that listening, and being humble in the presence of sound's specificities. Approaching sound and music from a not-knowing position, understanding EAM as an epistemic tool to engage the sounding world, and to ask questions of both listening and its objects was helpful in articulating my practices.

Working through the interiority-exteriority debate was crucial to thinking through the relations of sonic arts as both culturally and historically rooted in systems of meaning, open to conceptual art-like approaches beyond the merely subject-given perceptual, while at the same time recognising the acoustic evental flows and forces that exceed these. I think this is apparent in the trajectory of the works. *BGZ* and *Makharej* are clearly concerned with human systems of meaning, and *The Remainder* pulls decentring human phenomenality. Although the triptych performs a definite bracketing in of causal sources and references, they are by-and-large quite standard in their adherence to the acousmatic model of fixed-work, composer-diffuser, multi-channel concert system. Questions of transcendental subjects, the perceptual, conceptual and linguisticity, and interiority-exteriority play out in these works.

Specific compositional intentions were semantically encoded both indexically and symbolically into the sonic surface, which if received and interpreted by listeners, contribute significantly towards exerting their effects. This coding is highly layered. At the most superficial reading, the triptych indexes the MENASA region. A listener may not get further than that, in which case, the affective coding of the pieces, their movements between positively, negatively and ambivalently valenced affects are apprehendable, and the more specific semantic allusions may not register. However, for the suitably enculturated listener, very specific AO categories recur – Arabic letters, *adhan*, bird, wind and so on, each of which symbolically 'plug into' wider cultural understandings which have been discussed.

In terms of the debates of Chapter 2, they clearly engage linguisticity. Signifying networks are required to register the specific cultural locales of the AOs encountered, and the wider geopolitical contexts from which these pieces emerged, including the mediatized environment in which many listeners will be immersed. This requires activation of reflective processing and theory of mind networks. A certain problematicness must be introduced to present opacities to listening and recruit cognitive resource. Otherwise, they would be blandly referential and potentially orientalist – simply representing the status quo equating Islam with threat or exotic alterity.

The compositional intention is highly layered, as I have described in Chapter 5. By appropriating and intervening into indexically Islamic signs, the pieces perform the kind of reverse engineering that I have discussed in relation to the characteristics of AOs given in Box 2. Regarding Figure 11A, compositional manipulation of the material sign (which approximates to the ST topology as sensible exteriority) will modify the received relation to its apparent object (the categorization of the AO, its apparent 'where' characteristics and so on) under interpretation, forming the potential teleofunctional consequences for action relevance. Such transformations have the capacity to thus transmogrify the sign's apparent references, affording a play with expectations and intelligibility, in turn allowing a contestation of associated aesthetic regimens and cultural meanings. The recognizable, source-attributable AOs conveyed by the field recordings are examples of 'localised models' (Mackay et al., 2014: 6), which, through their technologically mediated transits and 'aesthetic reconfiguration' in the fixed EAM works, encourage a 'cognitive navigation' towards more 'universal address' (ibid). Transformations at the ST level transit these AOs chimerically, playing between signs, altering their inflections and their associated affects. These clearly technologically mediated processes become a form of comment on their semantic content, their charge and potentially disclose my own compositional orientation towards them. These compositional actions and transits are therefore a form of thinking in sound.

While at times there are clear soundscape allusions (especially in *BGZ*), and particular traces mark and locate the territory being presented, these are rarely presented unproblematically. The cultivation of a certain 'wrongness' presents opacities to listening, drawing cognitive resource and posing questions of the listening. The compositional treatments of the stem files in *BGZ*, through lineages of deformation and transit produce a progressive movement away from clear source-bonding, away from direct semantic reference, to highlight their artificial and mediated nature. These sonic images thus 'provid[e] new modes of epistemic traction by processing sensory data through symbolic formalisms and technological devices' (Mackay et al., 2014: 6).

So far, I have remained at the analytic discursive level. Perhaps most relevant to a practice-based research is to return to Di Scipio (1995: 369) in section 2.3.3. From a BPS_paC vertex what knowledge-level strategies (cognitive and aesthetic paradigms specific to the medium) are evident in these pieces?

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In *BGZ*, my interest in the specific conventions of Qur'anic recitation, and the sama' polemic led to a specific compositional strategy of removing any trace regarded as 'music' (and therefore haram). I became interested in the remaining materials. Pragmatically this required a strategy to compositionally organise the many AOs generated. The general technique of audio analysis and resynthesis is well known in EAM, but achieved here in a particular way.

I used psychoacoustic algorithms to extract key ST features and manipulated these data graphs to approximate sparse feature coding (like human perception). This was a hugely time consuming approach, but the use of analysis text files to drive synthesis generated materials that were perceptually related, keeping a focus on perceptible trace, without privileging a phenomenological perspective. In practice, fewer of the anticipated FEs were used. Silence detection segmented the large numbers of files, but had to be supervised, and thresholds suitably set to avoid segmentation at zero-crossing which generated too many files. Loudness fluctuation (approximating amplitude envelopes) and was used extensively to map loudness to response synths. Both sharpness and roughness were useful for spectral analysis, although pitch proved most useful when mapped to synthesis. The time-averaged power spectrum usefully grouped different stems according to average 'loudness'. The binaural attributes of auditory lateralisation and image width did not prove useful.

Exploitation of sound analysis artefacts proved highly generative and was happened upon quite fortuitously, providing lineages of related trace, and this was further emphasized through genetic algorithms and concatenative synthesis techniques. These in turn produced many files, and presented practical problems in both keeping track of the rapidly diversifying material, and of how to compositionally organise them.

The idea of chimera first arose through this piece as I returned to Bregman's writings on auditory scene analysis and the problems of perceptual binding. The problem was how to create perceptual coherences from such disparate materials. LiSa, with its on-the-fly loop processing capabilities, proved a useful intuitive way to develop parallel modulations across multi-channel audio combining disparate materials (into chimera) that could transit between recognizable signs and more textural and visceral noise which crucially developed the affective eventual components.

Reflecting on this piece, I think I compromised my initial idea of creating a self-organising database. This would have been more consistent with my eventual theoretical position of creating a composition that decentred human intentionality. For pragmatic reasons, I needed to complete the piece, and I opted for organizing the many fragments by using the original field recordings as templates into which I placed variations. This provided a punctualised form (in fact two – the concert and longer installation versions) in line with traditional acousmatic practice where the development moves largely spectromorphologically (in C-E stance) such that traces appear to causally propel the piece forwards. However, I also invested a great deal in capturing episodic trace which had personal significance. The argument at the Sultan Hassan is an example, many of the details of which will not be explicitly known or knowable to the general listener. While these may not be explicitly inferable, I think these episodic aspects are likely to have influenced my decisions in ways that are transparent to me, but none-the-less contribute to the efficaciousness of the piece.

These fragments, however, could have been organised otherwise and structured contingently in any number of ways. In fact, there is no necessity for it to have a final form. I plan to return to my initial intuition. This will be based on music information retrieval techniques to tag files with signal metadata, and to develop a 'decisional matrix' in supercollider to select from and control lineages to create a reconfiguring non-repeating installation. This has the advantages that I can add more recently recorded traces, for the piece to be in a constant state of evolution and to develop a general more 'cognitive' model based upon machine listening and learning contingencies.

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In *Makharej*, microphonic techniques captured variable degrees of listeners' apparent spatial proximity to the voice, affording access to the effortful biomechanical workings of the vocal tract (such as close proximity breath, uvular, tongue and palatal sounds), thus emphasising the corporeal.

The development of the *m-Log* enhanced we-centric exchange in improvisations with Amira and provided a tool used in other assemblages (particularly *R | S | E*, but also in several other live electronic performances not discussed here).

Extending from the perceptual analysis-resynthesis method of *BGZ*, this was an explicit attempt to model the RIA-helix through triple layers of DSP processing. Perceptual features (dynamic loudness, FFT spectrum, cepstrum, and Hilbert transforms) were extracted from AO exemplars to drive synthesis. Compared to *BGZ*, I used a reduced number of features. The cepstrum shows periodicities in the harmonic structure which were useful to map, especially for additive synthesis to set harmonic components. The Hilbert transform is a simple way of extracting the envelope of a signal outputting instantaneous loudness level (ILL), frequency and phase (the former two were used). ILL was useful to set loudness anchors or cues to temporally aligning different files in the DAW time-line in order to create composite objects e.g. a chimera made from multiple attacks. As in *BGZ*, frequency tracking was a simple way of aligning other synthesis processes.

Like *BGZ*, the process was laborious – running studio FE, generating the [sch] files, importing into the mapping layer, choosing how to map to [Sr]. However, it did give great latitude in how to parametise [Sr] tested in listening. Once a satisfying combination of [sch] mapped to [Sr] was arrived at, it tended to be retained, so usefully constraining the possibilities. Because of the time it took, not all possible combinations were practically explored.

Figure 23 showed many possible feature-extraction Max/MSP patches which were decided in advance of the work. In practice, only a relatively few were used. In future developments, it would be better to use algorithms which do not predetermine which features are most pertinent. An example might be K-means which solves this well-known problem by classifying data patterns in a given set through a certain number of clustered vectors (Kmeans, 2017).

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The 'two adjacent worlds' – generated in the Max/MSP patch architecture and evident in the final piece - worked well, and in performance with the *m-Log* it was useful to be able to switch between them, such as set a vocal following process in train, then switch away from it and improvise with it using other synths.

I was very fortunate to work with a collaborator who had at once a deep knowledge of the makharej, openness to experimentation, and patience with the rather laborious studio process. This led to an explicit consideration of the exteriority-interiority relation. I was necessarily concerned with focusing on the sensible features of the generated sounds (C-E stance) while Amira implicitly responded to these as motivated agents that indexed specific intentional states (X-I and C-I).

I envisage extensively using and developing the auditory object feature projection technique in future, through more sophisticated developments in the field of machine listening and machine learning. Linked to my discussions of the functional significance of the apophenic mode, it allowed perceptual features to be extracted and used to generate not-yet-known trace, but relieved of any obligation for these representations to have to be heard as related to their source. I maintain that the relation between the selected features, their compositional interpretation and final outcomes at the sonic surface do not by necessity need to be evident, although a more explicit play between the three terms could be a feature of future work. At times composition might intend these relations to be evident to listening e.g. in the *nuun* scene or the *miim* where the initial exemplar AO shares basic pitch relations and loudness envelopes with other AOs in the scene but have been processed to androgynise the 'voice'.

I used the technique to generate two contrasting and apparently separate world-models where these relations, while present, are opaque to listening e.g. the relation between the *alif* exemplar and *alif-baa'* scene, or the *laam*. None-the-less there are determining connections between the source features and subsequently derived materials. I found this a pragmatic means to experimentally generate materials whose adequacy was tested against auditive introspection. The *daal* and *dhaal* scenes are midway between opaque and transparent relation – the rather brittle sounding noisy attack sounds are derived from the onsets of both letters, their harmonic content filtered out and inharmonic components amplified. The amplitude envelope is relatively retained and maybe heard as perceptually related to their exemplars.

My aim with auditory object feature projection is to investigate the material ST realm, decentering phenomenality, and crossing the correlationalist adjacency between listener and acoustic event. While remaining phenomenally opaque, causal determinations exist. In both pieces, there is a telos operative which may not be apparent to the ear. Unlike the acousmatics, I am unconcerned by this. Because it cannot necessarily be heard, this does not mean that it is not there, nor am I concerned that this should be apparent. My point is that such organizing processes operate as scaffolds which may play out at the sonic surface, even if they are unavailable to explicit mentalization. They contribute to the experimental approach, they are techniques which can be tried out, and their effects tested in the listening.

❊

This compositional attitude is taken forward in *The Remainder* where the underlying grid structures the sonic surface, but again I do not think it matters greatly if this apparent to the listener. *The Remainder* retained the engagement with Islamic cultures but moved away from explicit play with acoustic signs indexing the human which was deployed in the other two pieces of the triptych. It turned to an old theme in music – mathematics, but this is not applied with the literal rigor of for example late serialism, or early algorithmic computer music. The hidden grid experimented with an inferred ST matrix, by projecting the sonic surface from an underlying structuring of time and other synthesis parameters outside of phenomenologically apparent causation, instead drawing from a general idea of algorithm to construct evental flows.

Like the object feature projection technique, I am not really concerned that this hidden ordering is necessarily apparent to audition. The matrix is simply a creative tool, a means to generate a formal structure which is deployed experimentally to see what can be achieved through it. This is perhaps my difference with formalist approaches. I am not concerned with using composition to simply illustrate an elegant formal process. Rather, it is simply a means to an end, to generate not-known possibilities, and I am quite happy for these to be intuitively intervened into through Xenakis 'epiphenomena of knowledge'. Perceptually, it is only apparent with the appearance of the seven beat aksak rhythm in the final sections. I do, however, think that the matrix' presence lends a coherent organising thread that moves through the piece, perhaps primarily because of the consistent use of specific synthesis algorithms which were re-parametised according to the resolution of the matrix as has been discussed.

My compositional focus was explicitly on exteriorities – with generating and transiting the ST topology without specific pre-conceptions as to traces possible interiorities (contrasting with *Makharej* or *BGZ*). I think it succeeds in this. None-the-less, listeners spontaneously made such attributions – evident by spontaneous interpretations of shifting motivated entities being present. One might expect this in relation to the more overt instrumental presences e.g. the traces attributable to santur or daf where human agency seems obviously causative. This observation between interiority and exteriority suggested that the two are not so much on a dimensional continuum, but operate in parallel, which was confirmed by my research into mentalization, and the double helices of Figure 14C.

This experiment with what Wishart called 'the grid', or Negarestani the 'bound cells' of 'topological neighbourhoods' puts me in mind of the acousmatic relation between syntactic dependencies and reference at the sonic surface. The term acousmatic thesis (as I have used it) is borrowed from Andy Hamilton who discusses the implications of this listening without seeing and particularly its application by the music philosopher Roger Scruton. Scruton takes acousmatic listening as the archetypal abstractionist and formalist position - a listening which detaches music from the world, rendering it 'the most abstract of the arts, a pure "art of tones"' (Hamilton 2007: 95). On these grounds (rather paradoxically), Scruton disqualifies musique concrete from being music precisely because of its use of referential real-world semantic specificities. Under this strong thesis, it is the abstract relations between elements (syntactic dependencies) which count as music, not the details of the sonic surface itself. This resonates with what Juha Ojala calls 'intrinsic musical space' in his discussion of Schaeffer's acousmatic dilemma (Ojala 2009: 347). While I have raised questions about the notion of the authentic when in Chapter 2 Schaeffer spoke of 'authentic musical perception' (Schaeffer, 1970: 75), I want to reconsider this in the light of the BPS_paC, and a domain of the K-matrix that I have said little about: intra-musical meaning.

Neurophysiologically[126], we can discern intra-musical meaning (in [D3] of Figure 4) as a form of non-conceptual knowledge that emerges from the perceptual, syntactic and earlier semantic relations that pertain between musical elements – the way in which one or more elements points to other elements. As touched upon in section 3.3.4, the K-matrix indicates that other hierarchically nested behaviours (such as actions and mathematics) exhibit such dependencies.

In the spectromorphological and space-form thinking of sound (Smalley 1997; 2007) emphasis is placed on the perceptual linkages of AOs to form apparently motivated behavioural semiosis – networks of dependencies, apparent contingencies between events.

[126] Intra-musical meaning is electrophysiologically indexed by the N5 ERP, distinguishing it from the acoustic signs just discussed. It is equivalent to Leonard Mayer's (1956) term 'embodied meaning' or Jean-Jacques Nattiez's (1990) 'intrinsic referring' (Koelsch 2013: 174).

While I have found this a useful approach, I have indicated that I think we can extend beyond it. I have commented on apophenic mode which can imaginatively decouple AOs from having to be consistent with any real-world (PSM modelled) expectations. Perhaps more significantly, a post-acousmatic approach might benefit from moving away from the phenomenological organization of sound and towards deploying formal mathematical relations to organise the ST topology. This is not a startling insight and has been pursued in a variety of ways by composers for many years. However, I am not thinking simply about mathematical modelling of pitch sets, probability sieves and so on.

The trajectory that I envisage, draws on topological mathematics, particularly through Guerrino Mazzola's methods to press against the limits of intra-musical meanings. By approaching music as a spectrotemporal topological plane that can be (infinitely) deformed and shaped, mathematical abstractions such as functors, operators and denotators offer ways of constructing chimeric morphisms that are not predicated on the limits of phenomenality, and potentially open out post-acousmatic practice (Mazzola, 2002). This approach builds on the discussion of topological transit introduced in section 4.1 to form a 'concept space [that] can be realised in [the] form of a veritable geometric space' (ibid: 36) which might afford speculative organisations of the ST topology. Perhaps more ambitiously, conjoining this with current developments in computational neuroscience aimed at mathematically modelling human auditory perception, suggests a fertile intersection to generate the sonic-not-known.

❊

Returning to my wider evaluation, *Batroun Concrète* was another means to compositionally investigate the RIA-helix relatively freed from the computer. It investigated the embodied nature of interaction, we-centric exchange with inanimate objects and acoustic spaces of a specific location. However, this enaction also took a more conceptual orientation, engaging not just the site-specific interactions with material, but also as an idea with a history, drawing from a narrative about that location. I believe it was successful in its aims of speculating upon the bodily-based nature of sonic thinking; however, I have no means to confirm that through the experience of performers as it was never presented in final form.

None-the-less, as I have commented earlier, I think it has given me a general model which I may apply to future site-specific work.

⁂

Realising that I needed a creative tool to model the interrelatedness of art concepts, material mediations and the BPS processes led to my adoption of assemblage and composition as primarily concerned with assembling trace through the heterogeneous engineering of disparate processes into coherences that produce a sonic surface. These came to the fore initially through *Batroun Concrète* and the live works, where their utility is apparent in the design and evolution of the *hQi.live* system. A set of BPS compositional concerns were developed across programming environments, chiefly modeling the RIA-helix, and using a re-entrant standing-context loop through which the sonic surfaces were generated. How successful is this notion of assemblage, and how convincing is its application here?

The key characteristics of a sonic assemblage is that it is a system of embedded systems through which a composer's activity leaves traces, and I understand these systems to be locatable within the BPS framework. Composing a sonic assemblage aims at generating outcomes (art-objects) which are 'traces which nothing else could have left' (Brün, 2004 (1970): 54). It is an aesthetically motivated activity, forming a coherence to generate something singular, an haecceity in Deleuzian terms. It is distinct from collage or montage because rather than juxtaposing elements it creates contingent relations between these components and emphasises 'emergence, heterogeneity, the decentered and the ephemeral in nonetheless ordered social life' (Marcus and Saka, 2006: 101)

I found that sonic assemblage offered a compositional handle on 'constellation[s] of mediations that chain and bring about [...] effects' (Bhunnoo, 2017: 97). It suites conceptual approaches to composition, the object-oriented programming (OOP) paradigm in EAM, and an experimental orientation to practice, creating a speculative laboratory to see what the assemblage can do when it punctualises to create an effect. Crucially, it allows for very different components to be brought into relation, covering a host of potential and actual actors – including everything from historical concepts, signal hardware, and funding grants through to instrumental traditions, compositional intentions and dynamics within a culture. It therefore structures a causal interaction space in which elements might be reacted together, in which 'techniques, processes and concepts can be formed into mutual relations and temporary dependencies' (ibid: 102). It is therefore a form of heterogeneous engineering.

The end-state achieved will be evaluated by how effectively it appears to operate as a single-point actor, and how the sonic assemblage exerts effects in its vicinity. This end-state effect could typically be a finished work e.g. a set of mastered sound files played back over a suitable system. Equally, in the case of hQi.live, it produces different instantiations for specific live performances. In both cases, it is its effect in producing a sonic surface in its 'characteristic, irreducible vagueness' (Bhunnoo, 2017: 101), a singular actual act of listening which matters. Such assemblages also point towards installation practices where they might operate contingently in their environment, with no fixed sonic surface, but producing one that adapts to context.

As I have admitted, my modelling of the RIA-helix and re-entrant loop has been crude. *CoP.live* added indeterminate processes that gave the illusion of a social agent, and *Dark Geometries* extended this, and provided a nice example of audience apophenic perception. I still have significant work to do for *hQi.live* to fulfil its potential as a self-organising system.

To an extent, I am happy with the trajectory the system has taken. However, its potential is underdeveloped and has some practical limitations. It requires time-intensive calibration to get the feature extractors to work adequately in different circumstances[127]. Each iteration is specifically tailored to each configuration of instruments and circumstance, and this is a pragmatic limitation on its generalisability. I am aware that with the rising and linked

[127] For example, changes in microphone sensitivities and placement, or room acoustics effect the normalisation of audio inputs and threshold settings for feature extractions such as loudness. This can result in the system behaving rather unpredictably. While these can be adjusted with appropriate set up time in a venue, this is a pragmatic constraint on the systems portability.

capabilities of music information retrieval, machine listening and machine learning, there is a great deal of scope for implementing my BPS models (such as the details of mnemonic systems, the various contributors to the reception, interpretation and action streams of the helix, and the re-entrant loop) more satisfactorily in computationally sophisticated systems, perhaps drawing on artificial intelligence and neuromorphic engineering. These approaches leverage biological, cognitive and engineering sciences to solve complex sensory and cognitive tasks. Recent developments in sensor design, algorithmic configurations and network-level processing have shown promise in solving complex visual tasks (Shih-Chii, 2017). Audio systems offer unique challenges including careful handling of temporal and spatial dimensions, issues related to temporal sampling and signal representation in both time and frequency, managing the redundancy in audio signals for complex detection and recognition tasks, as well as robust processing against noise and other interferers and maskers (although these apparent confounders may offer interesting compositional opportunities as I found in *BGZ*).

This is a trajectory that I am starting to pursue, particularly around modelling the decision-making, interpretive functions of the RIA-helix. I am interested in instantiating models that move from simple feature extraction, through higher-order pattern extraction towards symbolic 'tokens', perspectival 'addresses' or 'local topological neighbourhoods' and categories of features that can operate as high-level vectors to organise multiple tiers of response by the system (Griffiths et al., 1999: 366; Mazzola, 2002: 63; Negarestani, 2013: 200).

I have been looking more closely at cybernetic informed approaches such as Di Scipio's self-organising autopoietic systems and am keen to develop autonomous/semiautonomous systems that can work across live performance and installation contexts in which the idea of an agentive assemblage (beyond the simply interactive) becomes more palpably convincing.

7.3 Closing thoughts

I have made explicit links between Part 1 and Part 2, and considered ways in which the various pieces both responded to, and initiated my proposed BPS approach. In closing, I absolutely agree that it is high time that 'composition concerns itself about its application and stops to consider simple digital audio innovations as musically satisfying' (Dhomont, 2008, after Adkins et al., 2016: 121). I suggest that from such a perspective, the success of a piece is not simply marked by technical skills at rendering pristine panoramas, or competencies in transforming spectrotemporal morphisms to transit chimerae. Nor is it in innovating code or audio techniques. Rather, I suggest that the mark of post-acousmatic aesthetic beauty lays in its Socratic use, in whether 'it does what it's supposed to do really well' (Peter Wolfendale, in Beech *et al.*, 2014: 37). What matters is to consider what a sonic assemblage can do, to be concerned with the effects that it might exert in its vicinity as an agentive art-object. Clearly, for an art form closely aligned to technosocial developments, competencies in signal engineering are pragmatically useful, but I have suggested that as artists we are engaged in an odd kind of engineering which assembles heterogeneous materials and which crucially extends well beyond merely technological considerations.

The kind of post-acousmatic composition that I have advocated seeks the specificities of sounds traces, their haecceities as emergent from the construction of assemblages. These are on-the-fly coherences between a myriad of actors, which will proceed from an auditive perceptual base but include the conceptual, the technosocial and the vast litany of potential mediations through which any given composition might arise. What matters is what is at stake, what is contested and how this art pragmatically instrumentalises the aesthetic to exert its efficaciousness.

I think that a post-acousmatic practice is fundamentally about auditory phantasmogenesis, an imaginative generation of traces, which has a great deal to do with the kind of reverie and dreaming that Bion spoke about, and which Schaeffer charged Xenakis with. It is finding myself in altered states of consciousness, somewhere between intense concentration and mind-wandering dreaming which is most rewarding. Composition can be a critically engaged art-practice that offers unconstrained oneiric phantasy, reimagining possible listenings and sonic worlds through acoustic–events and their refiguration. It dreams the space in which sonic images give meaning to one another, and which may exert effects across bodies in actual acts of listening.

Appendices

A1.01: Compositions

The Appendices A1.1 to A1.7 include additional information about the sound pieces submitted in my research portfolio. They are broadly grouped into two streams, fixed electroacoustic assemblages and live assemblages, which developed in parallel during the research period. *Batroun Concrète* is a hybrid between the two.

The bird ghost at the zaouia, *Makharej* and *The Remainder* are fixed electroacoustic compositions that conceptually engage themes related to Islamic sonic culture. They are grouped as a triptych under the umbrella title *On the Admissibility of Sound as Music and Art*.

Batroun Concrète is comprised of electroacoustic parts and a score for structured site-specific improvisation by live performers.

Performance documentation for the live assemblages tracks the development of the *hQi.live* system between 2010 and 2016. *hQi.live* underwent iterative development and versions were used for *Reed | Skin | Elektrik* (live performance at the MazaJ Festival, 2010), a UK tour with the Conspirators of Pleasure trio and *Dark Geometries*, a performance as part of a group show in 2016.

A1.02: The bird ghost at the zaouia

Project description

Fixed electroacoustic, 7.1 multi-channel. There are two versions, one for concert, the other for installation (duration: 59:00). A stereo and multi-channel mix of the former is submitted here.

Documentation submitted

1. **fixed electroacoustic concert version (7.1 channel; 96KHz audio; duration: 30:09).** 8 mono audio files submitted: 8 mono files
2. **fixed electroacoustic concert version (stereo; 96KHz audio; duration: 30:09)**

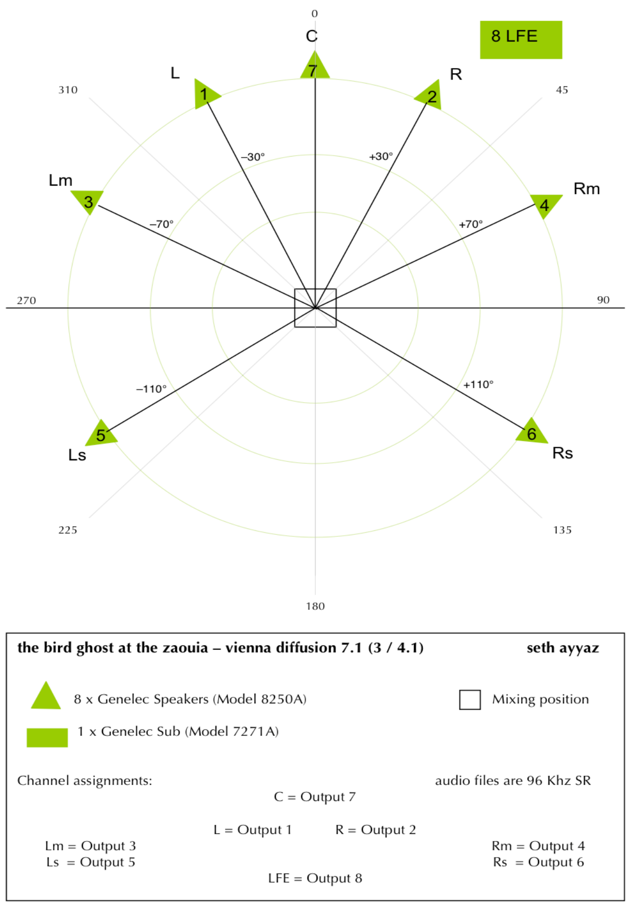


Figure A1.1: Loudspeaker diffusion schematics for *the bird ghost at the zaouia'*, Shut Up And Listen! festival, Echoraum, Vienna, 2011

Performances

World Forum for Acoustic Ecology Conference: Ideologies and Ethics in the Uses and Abuses of Sound. Koli, Finland, 17 June 2010.

Nour Festival installation, Leighton House Museum, London, 31 October–5 November 2011.

Shut Up And Listen! festival, Echoraum, Vienna, 10 December 2011.

Listening Through a Beam of Intense Darkness. fig-2, Institute of Contemporary Arts, London, 30 Nov–6 Dec 2015.

Related performative diagrams and publicity images

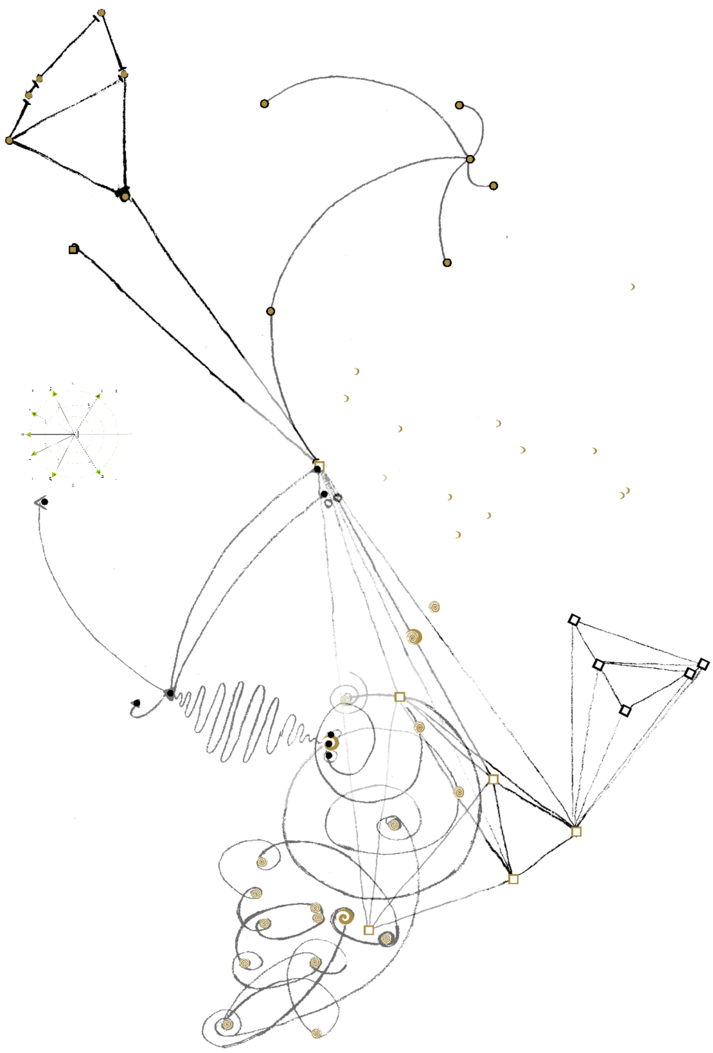


Figure A1.2: Seth Ayyaz – *the bird ghost at the zaouia*, Diagram of Forces, 2011

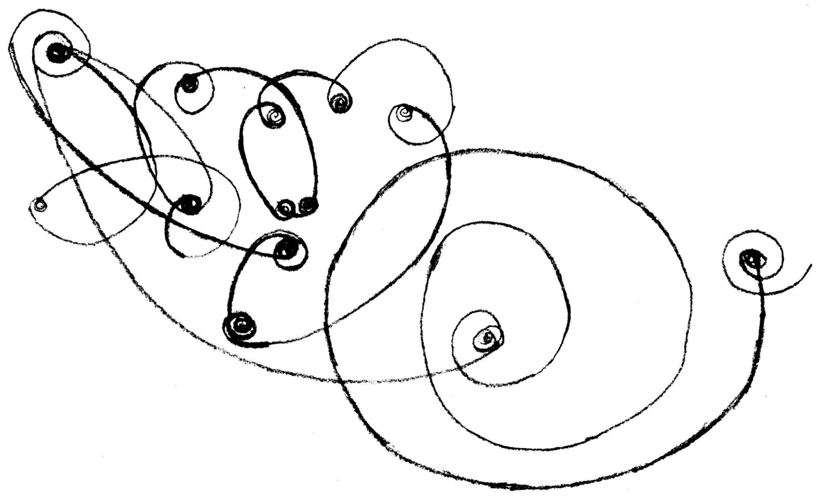


Figure A1.3: Seth Ayyaz – *the bird ghost at the zaouia*. Four Figures: Lilat Vortex, 2011

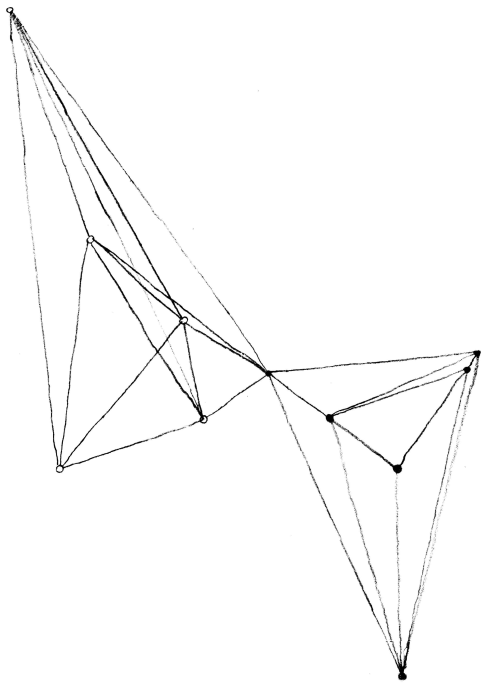


Figure A1.4: Seth Ayyaz – *the bird ghost at the zaouia*. Four Figures: After Ishaa Recedes Below

The Noise Floor, 2011

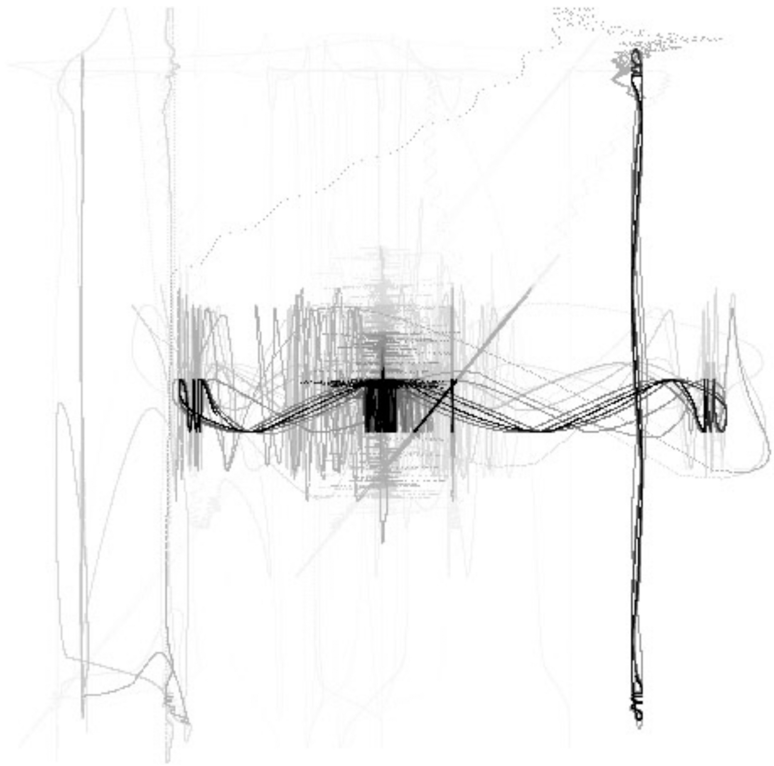


Figure A1.5: Seth Ayyaz – *the bird ghost at the zaouia*. Four Figures: Often Contains a Pool, Sometimes a Fountain 2011

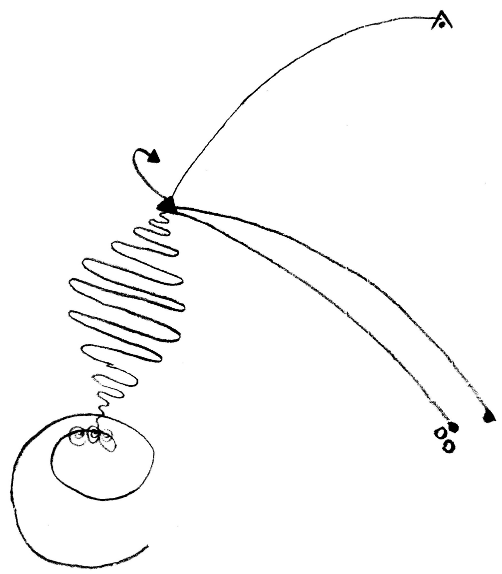
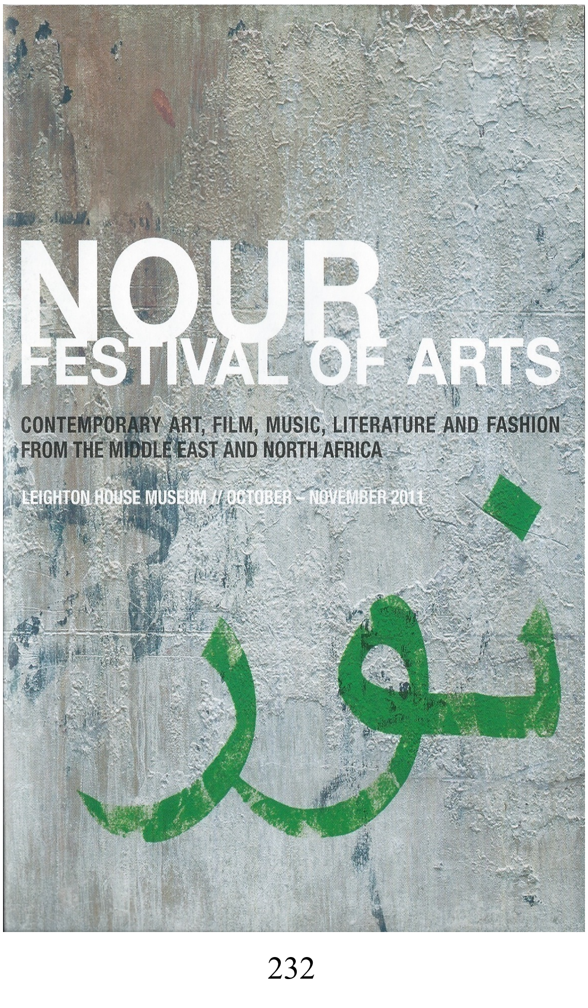


Figure A1.6: Seth Ayyaz – *the bird ghost at the zaouia*. Four Figures: Uses and Abuses of Sound, 2011

Figure A1.7: *The Bird Ghost at the Zaouia* [Digital]. Image by Thomas Qualmann (2011)



NOUR FESTIVAL OF ARTS | OCTOBER – NOVEMBER 2011

Welcome to the 2011 Nour Festival of Contemporary Middle Eastern and North African Arts at Leighton House Museum. The word Nour, which means 'light' or 'illumination' in various Middle Eastern languages, is an appropriate term for the Royal Borough's showcasing of some of the best art, film, literature, fashion and music originating within these diverse cultures.

The festival finds a natural home at Leighton House Museum, renowned across the UK and internationally as a site of major significance in terms of the meeting of East and West.

This year's festival is again international in scope, attracting leading names in contemporary Middle Eastern and North African art. Yet, it is also local. Arabic is the second most common language in the Royal Borough after English. The Nour Festival is particularly proud to be engaging so fully with our local communities and schools.

The 2011 Nour Festival promises to offer two months of scintillating arts and culture from across the Middle East and North Africa, and as Cabinet Member for Transport, Environment and Leisure services I'm delighted to introduce and recommend this unique and exciting showcase within the Royal Borough.

CLLR NICHOLAS PAGET-BROWN
Deputy Leader of the Council and Cabinet Member of Transport, Environment and Leisure Services

Figures A1.8 and A1.9: *the bird ghost at the zaouia*. Front image and introduction of exhibition catalogue of the Nour Festival of Arts October–November 2011. London: Leighton House Museum

SOUND ART INSTALLATION

A description of the installation by the sound artist Seth Ayyaz:

"The Bird Ghost at the Zaouia" is a composed machine for listening, a shifting sonic body that references, comments upon and reconfigures a notional Islamic sonic-social world through the politicised materiality of sound.

Between 2002 and 2010 I made many hours of recordings at various *zaouia* (Sufi shrines), mosques and religious spaces in Morocco, Egypt and Lebanon while attending various prayers and ceremonies (*adhan, salat, tilawa, dhikr, zar* and *lilat*). At the request of the respective religious leaders, no "musical" material has been used. I found birds, resonant tails, breathes, winds, noise, overheard conversations, *adhan* and extraneous sounds floating in, sounds that where left behind.

Orientalisation of sound is a kind of sonic tourism that captures the 'ethnic' and colonises the ear. The history of Leighton House and its association with the Imperial period offers a special context in which to immerse your ears.

SETH AYYAZ lives in London and is composer-performer spanning live electronics, free improvisation, noise, electroacoustics and Arabic music – principally *nay* (end-blown flute) *ghaita* (reed pipe) and *darbuka* and *daf* (hand percussion). Drawing on his background in neurosciences, his work is concerned with embodied perception and how this resonates across psychological and social spaces. www.sethayyaz.com

THE BIRD GHOST AT THE ZAOUIA –
AN 8-CHANNEL SOUND ART INSTALLATION
BY SETH AYYAZ
PRESENTED BY ZENITH FOUNDATION IN
ASSOCIATION WITH LEIGHTON HOUSE MUSEUM
October 31 – November 5

In partnership with ZENITH www.zenithfoundation.com

Figure A1.10: *the bird ghost at the zaouia*. Programme note in exhibition catalogue of the Nour Festival of Arts, October–November 2011. London: Leighton House Museum

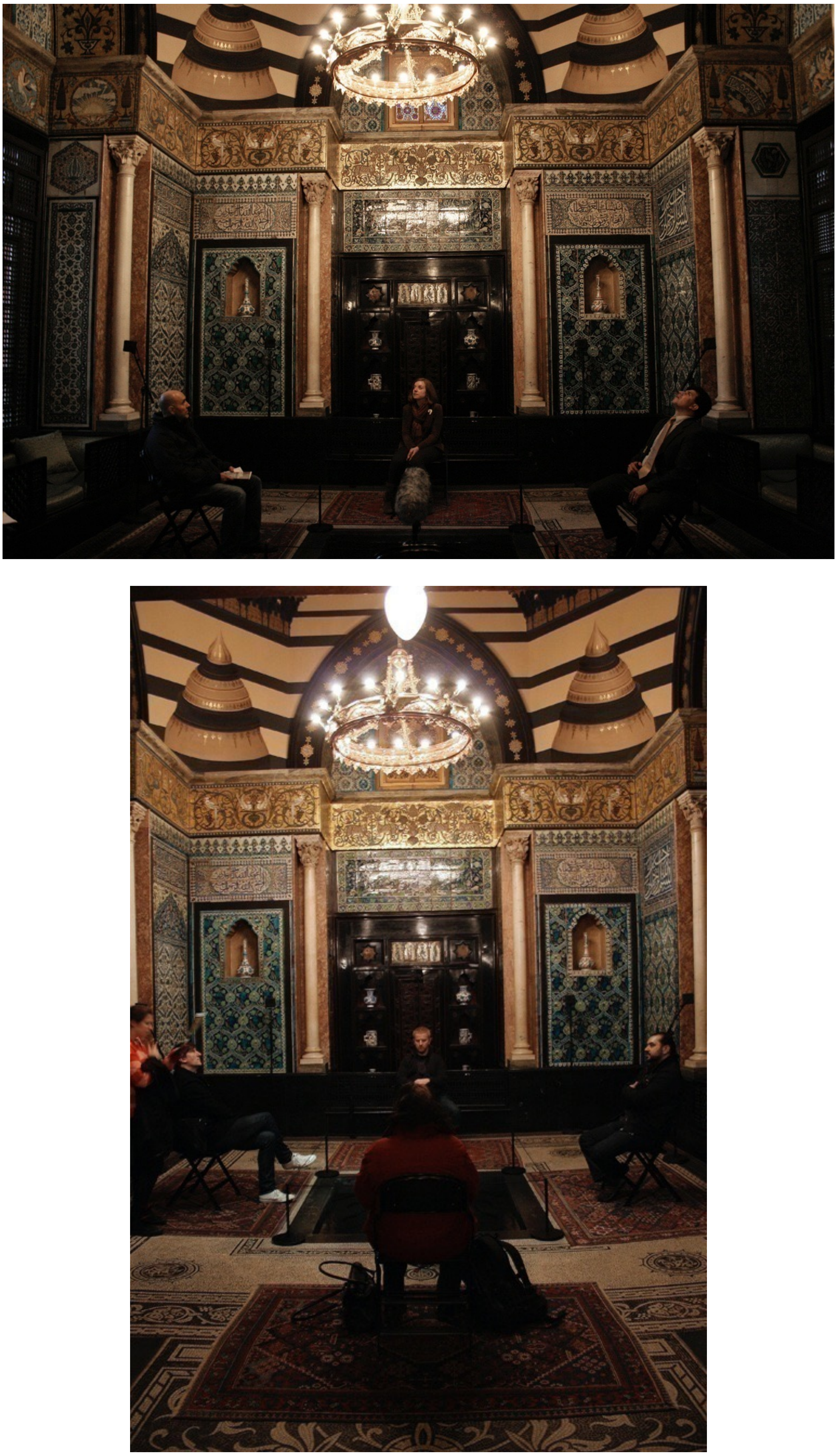


Figure A1.11: Listeners at *the bird ghost at the zaouia*. Nour Festival of Arts, October–November 2011. London: Leighton House Museum

A1.03: Makharej

Project description

Electroacoustic work for Arabic voice and electronics. Featuring: Amira Ghazalla (voice and body). Seth Ayyaz (breath, electronics, composition).

Documentation submitted

makharej (fixed) | 96.aif (stereo; 96 kHz, 24 bit; duration: 23:56)

makharej live (MazaJ 2010).m4v (video, resolution 640X360, AR: 16:9, FR: PAL; stereo audio duration: 24:48). Live performance at Volatile Frequencies concert at City University, London, part of the MazaJ Festival,18 November 2010.

Performances

City University, London, 16 November 2009. Live version, voice and electronics, 8 channel.

Cafe Oto, London, 28 February 2010. Live version, stereo.

MazaJ Festival (Volatile Frequencies Symposium), City University, London, 18 November 2010. Live version, 8 channel audio.

Irtijal Festival, Masrah Beirut, Beirut, Lebanon, 8 April 2011. Live version, 8 channel.

Auditory Cognition Summer School, University of Plymouth, 21 July 2012. Diffusion of fixed version, and discussion of composition techniques.

Listening Through a Beam of Intense Darkness, fig-2, Institute of Contemporary Arts, London, 30 Nov–6 Dec 2015.

Programme notes

(from the *Makharej* premiere at City University, London, 16 November 2009)

> '… in the emptiness, I disassembled a letter from one of the ancient alphabets, and I leaned on absence …' from In Her Absence I Created Her Image by Mahmoud Darwish

This is a piece for vocal performer (Amira Ghazalla) and electronics that formally investigates the phonetic possibilities of the 28 letters of the Arabic alphabet. Literally *makharej* means place of origination, or exit, and this is taken as a cue to investigate the embodied nature of vocalisation.

Repetition of the divine letters is part of an Islamic enculturation. They carry a social/religious authority. This theme of ownership of the letters is explored, moving between the prescribed 'correct' articulation and an exploration of the sonic potential latent within their embodiment in sound. Transformations of the 'correct' pronunciation, produces distortions in a cultural, semantic linguistic sense.

> The Breath of the All-merciful: 'Just as the Arabic alphabet has twenty-eight letters through which the names of all things may be pronounced, so the cosmos has twenty-eight basic 'letters' which combine to produce all created things. Each letter of the alphabet issues from a particular point, known as the 'place of articulation' (makhraj) within the vocal apparatus. Depending on how the breath passes through the throat and mouth, that is, which 'place of articulation' is employed, letters are produced which may be guttural, velar, palatal, dental, labial and so on'
>
> 'From the Breath of the All-merciful become manifest the letters of engendered existence and the words of the cosmos in accordance with the different levels of the places of articulation within the breath of the human breather, for the human being is the most perfect of all configurations (nash'a) in the cosmos. These places of articulation are twenty-eight letters. Each letter has a name which is determined by its own place of vocalisation (maqta'). The first of these letters is ha' and the last is waw'
>
> Ibn al-Arabi, Metaphysics of Imagination, The Sufi Path of Knowledge, translated by William C. Chittick. State University of New York Press, 1989: 127.

In addition, in more everyday use, *makhraj* is 'exit' and may mean a denouement, a way of making a graceful exit from a difficult situation.

The 28 letters were recorded 'dry' in the studio – each letter by name and sound. Exemplars of each category of the sounds were selected according to somatic production, place of articulation, exit from the body:

- elongated – along the breath, continuous, resonant
- with air
- plosive – short, iterative

There are many complex sounds e.g ل (laam) from the tongue, teeth, sinuses; م (miim) from a closed mouth; خ (khaa') from soft palette and in the throat; ح (H'aa') from the abdomen, back of the throat and open mouthed. These files were analysed for psychoacoustic cues using Psysound 3 software to generate text files that were used to drive processing. There are two levels of transformation. The voice is treated subtly, with changes still intended to be heard as voice, but extending the voice beyond biological parameters. The second tier of processing is overtly electronic. A moment form is adopted to characterise each letter. Processing is partially pre-prepared in the studio to obtain a degree of subtlety and detail that is illusive in real time. These transformations are used alongside real-time processing in a live performance context.

Just as each letter has its distinct identity so too does its electronic context. Textures and spectromorphologies are deployed to offer a context for the live voice to be situated, they are intentionally constrained, sparse and noise based. The same voice speaks at times simultaneously from different locations – an impossible embodiment, that carries connotations for the subject position present in the music, and implications for the listening.

Additional texts: In Her Absence I Created Her Image

In her absence I created her image: out of the earthly
the hidden heavenly commences. I am here weighing
the expanse with the Jahili odes … and absence

is the guide, it is the guide. For each rhyme a tent
is pitched. And for each thing blowing in the wind
a rhyme. Absence teaches me its lesson: If it weren't
for the mirage you wouldn't have been steadfast …
Then in the emptiness, I disassembled a letter from one
of the ancient alphabets, and I leaned on absence. So who am I
after the visitation? A bird, or a passerby amid the symbols
and the memory vendors? As if I were an antique piece,
as if I were a ghost sneaking in from Yabous, telling myself:
Let's go to the seven hills. Then I placed
my mask on a stone, and walked as the sleepless
walk, led by my dream. And from one moon
to another I leapt. There is enough of unconsciousness
to liberate things from their history. And there
is enough of history to liberate unconsciousness
from its ascension. Take me to our early
years – my first girlfriend says. Leave
the windows open for the house sparrow to enter
your dream – I say … then I awaken, and no city is in
the city. No 'here' except 'there.' And no there
but here. If it weren't for the mirage
I wouldn't have walked to the seven hills …
if it weren't for the mirage!

Source: The Butterfly's Burden (Copper Canyon Press, 2007).

Arabic alphabet

ا	alif	د	daal	ض	Daad	ك	kaaf
ب	baa'	ذ	dhaal	ط	Ta'	ل	laam
ت	taa'	ر	raa'	ظ	Th:aa'	م	miim
ث	th!aa'	ز	zaay	ع	ghayn	ن	nuun
ج	jiim	س	siin	غ	ghayn	ه	haa'
ح	H'aa'	ش	shiin	ف	faa'	و	waaw
خ	khaa'	ص	Saad	ق	qaaf	ي	yaa'

Performance images

A

B

C

D

Figure A1.12: *Makharej* live performance duo: Seth Ayyaz and Amira Ghazalla. (A and B) at Volatile Frequencies, City University, London, November 2010 (C and D) Irtijal Festival, Lebanon, 2011 (photographs by Tanya Trablousi)

A1.04: The Remainder

Project description

8 channel, fixed electroacoustic. Commissioned for Maerz Musik 13, Berlin, 2013.

Documentation submitted

1. **fixed electroacoustic concert version (8 channel; 96KHz audio; duration: 13:20).**
2. **fixed electroacoustic concert version (stereo; 96KHz audio; duration: 13:20)**

Diffusion Schematic

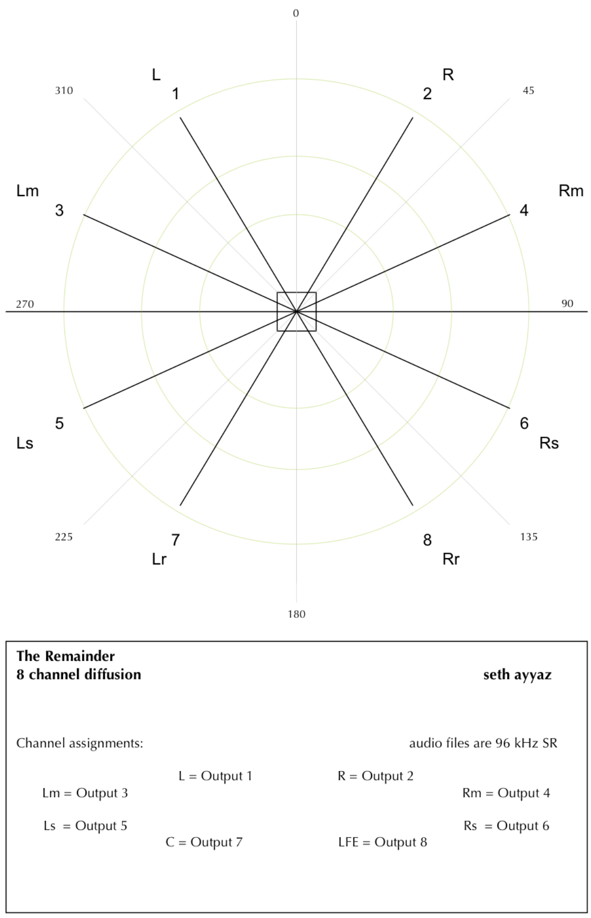


Figure A1.13: Standard 8 channel diffusion for *The Remainder*

Maerz Musik (Berlin March 2013)

Artist: Seth Ayyaz (London) www.sethayyaz.com

Title: The Remainder **(8 channel electronic work, 12 minute duration)**

Program Notes:

The Remainder (8 channel electronic work, 12 minute duration) at Maerz Musik 2013.

Qur'an 11:86: "Allah's remainder (is) best for you if you were believing, and I am not with a protector/observer on you." But who is this Allah, who leaves behind a remainder? Is he other than the Allah, the One, the Almighty, and the Allah of La Ilaha Illa Allah? There can never be any remainder for Him.

THE REMAINDER is the number that is left over after all the operations of division have been completed, it is the smallest of the divisor, dividend and quotient, therefore it can not be divided any further. Within Islamic debates, the remainder is contentious. It is that which is left over and that threatens the wahdaaniyyah, the Unicity of God, since there is only one substance, one God, nothing may remain.

Within the Qur'an are combinations of letters (such as alif-laam-miim, ya-seen, Ha-miim) which appear alone without comment or context. They are remainders that stand within the text. Known as Al-Muqattaat (the abbreviated letters) they are sometimes referred to as 'the keys' and have been the focus of debate and mystical interpretation. They are often taken as openings into transcendental experience, forming the basis of meditations. In The Remainder, it is these 'keys' and the breath, those elements that remains outside language that are of interest - using the breath and the often hidden or transformed deconstructions of the keys. Working with the synthesis language Supercollider, the piece uses machine-listening techniques; the voice drives elemental synthetic processes that transform and shroud it.

A continuation from the earlier concerns of 'Makharej', this work forms part of a suite, drawing from an ongoing collaboration with Amira Ghazalla into the unseen, unspoken and potentially revolutionary problematics of interrogating power, by disassembling the authority of the Arabic letters, the Law. Makharej was concerned primarily with opening the spaces of the letters drawing equally from the traditions of Qur'anic recitations (tilawa and tajwid) and sound poetry (such as Kurt Schwitters Ursonate), and The Remainder continues that trajectory.

Makharej is to be released as a limited vinyl edition on the Belgium Label ini.itu later this year and will include a stereo version of The Remainder.

Additional

HALIM EL-DABH
Der Komponist und Musikethnologe Halim El-Dabh wurde 1921 in Kairo geboren. Er ist ein Pionier der elektronischen Musik und machte 1944 erste Klangexperimente.1950 ging er in die USA, erforschte die Musik der amerikanischen Ureinwohner und studierte Komposition bei Aaron Copland und Irving Fine am Berkshire Music Center in Massachusetts. Ende der 1950er Jahre arbeitete El-Dabh am Columbia-Princeton Electronic Music Center in New York. Er komponierte elektronische Musik, Opern, Symphonien, Kammermusikwerke und Ballettmusiken für Martha Graham. Seine musikethnologischen Forschungen haben zum Einfluss arabischer, afrikanischer und sogar altägyptischer Elemente auf seine Musik geführt. Von 1969 bis 1991 war er Professor an der Kent State University Hugh A. Glauser School of Music in Ohio.

www.halimeldabh.com

BÜLENT AREL
Der aus Istanbul stammende Komponist und Tontechniker Bülent Arel (1919-1990) studierte in Ankara und Paris, unterrichtete am Konservatorium von Ankara und war von 1951 bis 1959 erster musikalischer Leiter von Radio Ankara. 1959 lud ihn die Rockefeller Foundation ein, am Columbia-Princeton Electronic Music Center in New York mitzuwirken. 1962 arbeitete Arel mit Edgard Varèse an „Déserts". Arel plante und installierte auch das elektronische Musikstudio an der Yale University in New Haven, Connecticut, wo er von 1961 bis 1970 lehrte. Außerdem gründete er den Studiengang für elektronische Musik in Stony Brook an der State University of New York, wo er von 1971 bis 1989 lehrte. Arel hat neben seiner elektronischen Musik auch Kammermusik, Vokalmusik und sinfonische Werke geschrieben.

İLHAN MIMAROĞLU
İlhan Mimaroğlu wurde 1926 in Istanbul geboren und starb 2012 in New York. Sein Vater war der berühmte Architekt Mimar Kemaleddin Bey. 1949 machte Mimaroğlu seinen Abschluss in Jura an der Ankara Üniversitesi. Mit einem Rockefeller-Stipendium ging er 1955 nach New York und studierte an der Columbia University Musikwissenschaft bei Paul Henry Lang und Komposition bei Douglas Moore. Außerdem arbeitete Mimaroğlu am Columbia-Princeton Electronic Music Center in New York. Er war hier Schüler von Vladimir Ussachevsky. Mimaroğlu komponierte Instrumentalwerke und elektronische Musik, die noch zu entdecken sind. Denn Karriere machte er vor allem als Schallplattenproduzent: Er arbeitete mit Jazz-Größen wie Charles Mingus, Freddie Hubbard, The Modern Jazz Quartet, Mose Allison, Sonny Sharrock und Don Pullen.

MAZEN HUSSEIN
Mazen Hussein wurde 1972 in Aleppo, Syrien, geboren. Er studierte Bratsche, arabische Zither und Musiktheorie an der Musikhochschule in Damaskus. Von 1994 bis 2003 war er Mitglied des nationalen Symphonieorchesters von Damaskus, das international tourte. Neben der arabischen Musik und Kultur ist die elektroakustische Musik prägend für seine Werke. 2003 bis 2006 hat er am Conservatoire National de Musique de Toulouse bei Bertrand Dubedout elektronische Musik studiert. Husseins Komposition „Hommage" wurde 2006 beim internationalen elektronischen Musikwettbewerb Bourges in Frankreich ausgezeichnet. Er gab zahlreiche Konzerte in Frankreich und im Nahen Osten. Seit 2006 lebt er in Berlin, wo er komponiert, unterrichtet, in mehreren Theaterprojekten mitwirkt und das ar-Rumi-Ensemble leitet.

www.myspace.com/mazenhussein

MEHMET CAN ÖZER
Mehmet Can Özer wurde 1981 geboren. Er studierte Komposition an der Bilkent Üniversitesi in Ankara. Anschließend setzte er seine Studien in Komposition und in elektronischer Musik am Konservatorium in Genf bei Michael Jarrell und Rainer Boesch fort und studierte in Zürich bei Gerald Bennett. Seit 2005 ist er Hochschullehrer in Ankara. Er gewann mehrere Preise, seine Werke werden auf internationalen Festivals und Projekten vorgestellt. 2005 rief Özer in Ankara eine Konzertreihe mit elektronischer Musik ins Leben und er gibt Improvisationskonzerte in der Türkei. 2008 komponierte er Musik für Ernst Lubitschs Stummfilm „Die Austernprinzessin" (1919). Özer hat eine eigene Software („Asure") entwickelt, die er in seinen Konzerten anwendet. Gleichzeitig schreibt er auch für traditionelle Instrumente.

www.mehmetcanozer.com

SETH AYYAZ
Seth Ayyaz lebt in London. Er widmet sich der Live-Electronik, der freien Improvisation, Noise sowie elektronischer und traditioneller arabischer Musik. Er spielt die arabische Flöte Nay, das Doppelrohrblattinstrument Ghaita und diverse arabische Handtrommeln. Ayyaz studierte elektronische und Computer-Musik an der City University London. Da er einen Hintergrund in Neurowissenschaft hat, interessiert ihn als Komponist die Wahrnehmung von Klängen in psychologischer und sozialer Hinsicht: Auf dem World Forum for Acoustic Ecology (2010) in Finnland hat Ayyaz eine „Hörmaschine" präsentiert, die Fragmente islamischer Rituale erklingen ließ. In „Makharej" (2009) hat er die Klanglichkeit des arabischen Alphabets erforscht, „Those That Fly" (2003) behandelt den Raketenbeschuss auf Bagdad während des Irakkriegs.

www.sethayyaz.zenithfoundation.com

ALPER MARAL
Alper Maral hat zuerst ein Studium an der School of Economics der Universität Istanbul abgeschlossen. Danach studierte er Musikwissenschaft und Komposition am Sozialwissenschaftlichen Institut der Ägais Universität in Izmir. Sein kompositorisches Oeuvre umfasst inzwischen mehr als 1000 Werke, die heute in der Türkei und auch außerhalb aufgeführt, veröffentlicht und verbreitet werden. Vielfach wurde er für seine Filmmusiken geehrt. Außer als Komponist arbeitet er auch als Wissenschaftler und Lehrer, unterrichtet elektroakustische Musik, Komposition und Musikwissenschaft. Musik und sozialer Kontext ist Thema vieler seiner Artikel. Neben Theater- und Filmmusikwerken, schreibt er auch Kammeropern, multimediale Kompositionen. Vor allem seine elektroakustischen Kompositionen mit der für ihn typischen dramatischen Konstruktion und der von ihm thematisierten wechselseitigen Beziehung von Musik und ihrem kulturellen Kontext haben ihn bekannt gemacht. Als Komponist ist er in verschiedenste Kontexte, Projekte und Ensembles eingebunden, so in dem Controle Voltage Projekt, dem Bornova Trio, A-415, Istanbul Baroque Community and Karinca Kabilesi, das von ihm gegründet wurde. Zurzeit lehrt er Komposition, Musikwissenschaft und Tontechnik an der Yıldız Technical University, Galatasaray University und der Bilgi University.

[UM]BRÜCHE:
FROM MUSIQUE CONCRÈTE TO THE DIGITAL AGE

Pioniere: Türkische und arabische Komponisten am Columbia-Princeton Electronic Music Center (1944–1965)

HALIM EL-DABH
Wire Recorder Piece (1944) 2'
Meditation in White Sound (1959) 6'

BÜLENT AREL
Stereo Electronic Music No. 1 (1961) 10'

İLHAN MIMAROĞLU
Agony (1965) 9'

Die neue Generation: Elektroakustische Musik

MAZEN HUSSEIN
Mémoire – Départ (2007) 13'

MEHMET CAN ÖZER
Leibniz'e (2009) 14'

SETH AYYAZ
The Remainder (2012) 12 '

ALPER MARAL
Theater Entropie (2011) 7'

Seth Ayyaz/Alper Maral/Oliver Schneller, Klangregie

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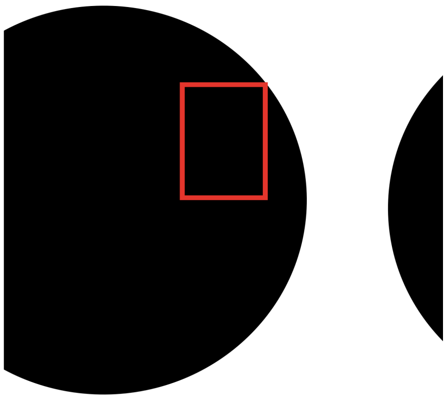

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A1.05: Batroun Concrète

Project description

Site specific commission for Batroun Projects art space in Batroun, Lebanon (2011). *Batroun Concrète* 0.0 is a fixed electroacoustic piece made for the opening of the space (not submitted). *Batroun Concrète* 2.1–2.9 is a mixed electroacoustic and live acoustic performance version that was due to be realised in 2012. Unfortunately. the musicians involved were unable to travel due to safety concerns arising from political instability, and the work was never fully realised as proposed.

Documentation submitted

1. AUDIO: **fixed electroacoustic concert version (2 channel; 48KHz audio; total duration: 19:12)** contains the following fixed parts: part 2.1 (duration: 07:24); part 2.3 (duration: 02:12); part 2.5 (duration: 02:43); part 2.7 (duration: 02:54); part 2.9 (duration: 03:33).

2. SCORE: Batroun Concrète 2.1-2.9 score (2012).pdf (also included below).

Performances

Batroun Concrète 0.0 (first commissioned version), performed April 2011 for the opening of art space Batroun Projects, Batroun, Lebanon.

Batroun Concrète parts 2.1, 2.3, 2.5, 2.7 and 2.9, City University, London, 20 November 2012

Batroun Concrète parts 2.1, 2.3, 2.5, 2.7 and 2.9 (electro-acoustic parts only) performed at Quantum Fluctuations in a Synechdochic Universe, Beirut, 4–9 December 2012.

Full version, with live performance, has not realised.

IBRAAZ

BATROUN CONCRÈTE 0.0

Batroun Projects

1 November 2011

Batroun Projects is a multidisciplinary project space and residency in the north of Lebanon. Batroun Projects is a platform that supports and showcases the ideas, processes and works of emerging artists, writers, actors, researchers and curators through a dynamic residency and events programme.

Batroun Projects will be a multidisciplinary project space and residency in the north of Lebanon. Batroun Projects will be a platform that supports and showcases the ideas, processes and works of emerging artists, writers, actors, researchers and curators through a dynamic residency and events programme.

Batroun Projects is a multistory house on the beach in the north of Lebanon. Batroun Projects is: high vaulted ceilings, arched doorways, exterior and interior spaces and concrete appendages. It has been empty for 30 years. Sounds are gathered from over and in between its layers of concrete. Fresh water flows under the house, through a hollow well, out to the sea.

Batroun Concrète 0.0 is a series of performances-to-microphone using objects and materials found in the space to activate it sonically, intervening to focus the ears. These performances were then assembled with no processing and minimal editing. This piece was commissioned as part of the Batroun Projects Sonic Art Jukebox 2011.

Seth Ayyaz
Batroun Concrète 0.0, 2011
Microphonic dereliction potential, audio, 21'36".
Courtesy of the artist.

Seth Ayyaz lives in London and is a composer-performer whose work spans live electronics, free improvisation, noise, electroacoustics and Arabic music - principally the 'nay' (end-blown flute), 'ghaita' (reed pipe) and hand percussion ('darbuka' and 'daf'). Ayyaz studied acousmatic music at City University, London, specialising in live electronics and machine-listening, building custom software/hardware ecologies for specific performances.

About the author

Batroun Projects is Nora Razian, Ghassan Maasri, Lawrence Abu Hamdan and Gressy Kossaify.

http://www.ibraaz.org/projects/4

Programme notes

(City University, London, 20 November 2012) Batroun Concrète (2.1, 2.3, 2.5, 2.7,2.9). Five movements. Stereo. Duration 19:21.

The original *Batroun Concrète* 0.0 was commissioned as part of the Batroun Projects Sonic Art Jukebox in April 2011. Batroun Projects is a multidisciplinary space and residency; a multi-story house on the beach in the north of Lebanon. It is: high vaulted ceilings, arched doorways, exterior and interior spaces and concrete appendages. It has been empty for 30 years. My approach drew from uncertainty, horror, seduction and speculation about the presences and fictions that the derelict house evoked. The motivations and intentions that lay behind the construction of the house are unclear. We are compelled to speculate. It was built in the 1980s, never completed and was shelled. There is a curious incoherence between its external appearance and its internal spaces. Hidden within are interstitial spaces, false floors, secret storage recesses, and in the basement an inaccessible void. A tunnel runs from the house to the sea. Sounds were gathered from over and in between its layers of concrete. This is a site report of a series of events that may have happened.

The first constraint was to use only found materials, the architectural acoustics and recording equipment. I made a series of performances to microphone, coupling myself, the materials and the space into a system for generating sound enactively, finding what might be possible.

The five movements use different basic metaphors of spatial-relations that underpin thinking. The container schema deals with a bounded space in a region. It constructs an interior/exterior. It protects the container's contents, restricts their motion and renders the interior inaccessible to vision. The source-path-goal schema constructs a trajectory, a movement from source location to a final destination. The bodily projection schema deals with orientation and spatial position, the way in which our bodies shape conceptual structure.

The second constraint was to use the concrete sounds with only limited editing. The intention is to preserve the unfolding between body-objects-acoustic-ears. The approach has more in common with my work as an improviser, where actions cannot be retrieved, only reconsidered, embellished, or abandoned.

Tonight presents the electroacoustic versions part of 2.1 to 2.9. The five movements form a series of speculative compositions, placed in uncertain relation to the house and its resonances. The scored version of this piece will be performed as part of QUANTUM FLUCTUATIONS IN A SYNECHDOCHIC UNIVERSE curated by Sara Giannini and Fatos Ustek for the OuUnPo collective at Batroun Project, Lebanon, 8 December 2012.

Curatorial Statement: QUANTUM FLUCTUATIONS IN A SYNECHDOCHIC UNIVERSE

The synecdoche is a figure of speech, which involves an intermitted yet visionary perception. Rearticulating language and image within a tropic space, the synecdoche subverts absence and presence and points a finger at a lack. In everyday language it is used in 'part-whole' conventional implications, i.e. wherein the part of an object stands for the object in all its complexity. The creation of a fictional and a posterior 'missing architecture' has to do with a wandering and questioning position that tries to reconstruct a meaningful universe from a discontinuous landscape of fragments.

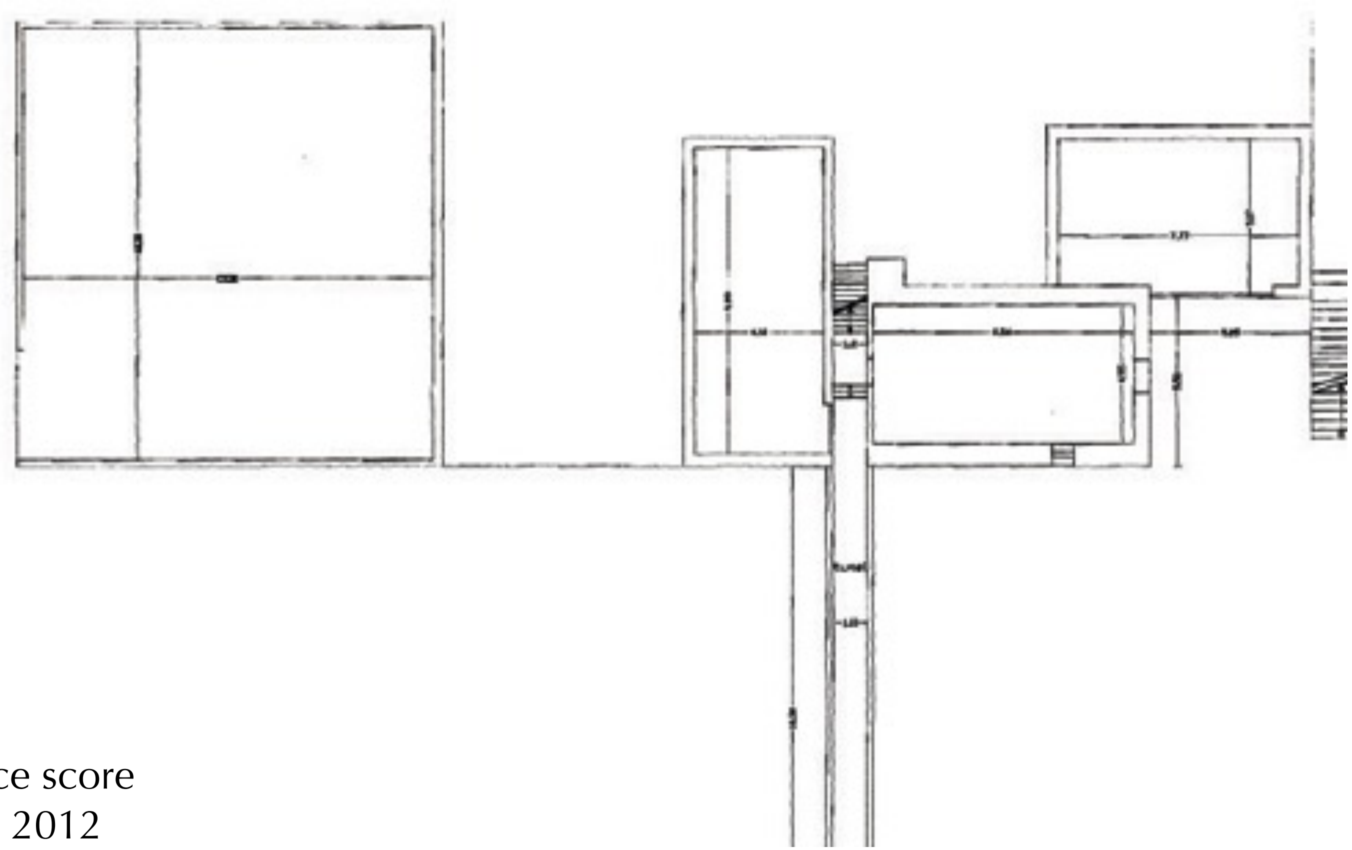
As Lebanese architect and theorist Tony Chakar told us over an orange juice in Beirut in September 2012, Beirut is a palimpsest. Beirut will be our synechdochic universe, composed of fragments, residuals, details that could eventually compose a visionary bigger picture. The implication of the absent refers and calls into further investigation the conventional habitus of seeing. By means of a synechdochic perception, the gaze creates an eloquent environment and invests components and particles of narratives, contents and aesthetics, which are inevitably affected by a social biography of voyeurism. We don't forget but insist on the cultural eye that approaches Beirut and selects an extract of it, fills it out with significance, relevance and description. It's precisely this sort of invention of the world that we would like to address as our ground of experience, an invention that is filtered by a personal, collective and mediated imagery. Since the look at the exterior is nourished by a home soil, it will be possible to explore a shared terrain in which the 'other' becomes 'another self', in which two singularities can become a unique reciprocity.

In quantum physics the quantum vacuum fluctuation is instead regarded as a temporary change in the amount of energy in the empty space, which has allegedly contributed to structure the primordial universe. OuUnPo – Ouvrier d'Univers Potentiels is a group of loose particles that share and experiment their being together for a given duration and context. It is not a collective but a gathering of artists, curators, researchers and scientists that investigate the potential of the encounter on the occasion of meetings in various cities of the world. We learn how to move in altered space-temporal categories and love to meet with other loose particles regardless of pre-existing systems and bounds.

We imagined our movements and encounters in Beirut as an infinitesimal and temporary shift of energy in a fictional context of speculations, déjà vu, and castles in the air.

Sara Giannini and Fatos Ustek (2012)

Batroun Concrète (2.1 - 2.9)



Performance score
Seth Ayyaz 2012

Batroun Concrète (2.1 – 2.9)

Batroun Concrète (2.1, 2.3, 2.5, 2.7,2.9) emerged from Batroun Concrète 0.0, a fixed 2-channel electroacoustic piece.

This scores structures a nine-part site-specific composition which alternates sections for stereo loudspeaker, with four live performances.

Batroun Projects was a multidisciplinary residency arts space; a multi-story house on the beach in the north of Lebanon. It was a place of dereliction, a potential and oneiric space, an exercise in negative capability. It had been empty for 30 years.

The motivations and intentions that lay behind the construction of a house, currently known as the Batroun Project, on the outskirts of the town of Batroun in Lebanon are unclear. We are compelled to speculate. That it was never completed is certain. That it was built sometime in the mid-1980s, during the war, is certain. That it was shelled is clear.

The significance of its proximity to a Syrian checkpoint is conjectured upon. That no other structures in the area were targeted is the case. Perhaps the structure and fabric of the house contains certain clues. The large construction of concrete, with multiple rooms, in a typical flat roof style, is perhaps unremarkable. It gives the air of a thwarted seaside villa. It sits set down from a road, on the approach to the town, right by the sea. It was never finished, and abandoned (presumably after the rocket attack).

There is a strange contradiction between its external and outward facing aspects and its internal spaces. Hidden within are a series of interstitial spaces, false floors, secret storage recesses, and in the basement a sealed, vast, inaccessible void containing water. A tunnel runs from the house down to the sea, not visible from the road.

Batroun Concrète (2.1 – 2.9)

Sounding in The Flesh: Basic-Level Cognitive Strategies

The nine movements each draw on different basic cognitive models, the metaphors of spatial-relations, which underpin thinking which is described in Lakoff & Johnson's influential *Philosophy in the Flesh* (1999). These authors describe the way in which our conceptual apparatus projects outwards from the basic conditions of being a body oriented in a world.

In the score these basic schemata are indicated in square brackets [ ].

[Container] schema deals with a bounded space within a defined region. It constructs an interior/exterior. It protect the containers contents, restricts their motion and renders the interior inaccessible to vision.

[Source-Path-Goal] schema constructs a trajectory, a movement from source location to a final destination.

[Orientation and Bodily Projection] schema deals with orientation and spatial position, the way in which our bodies shape conceptual structure.

"There is a relatively small collection of primitive image schemas that structure systems of spatial relations in the world's languages. Here are some examples…" (ibid: 35)

[Perimeter -> Centre] [Movements have trajectory] [Contact]
[Adjacency] [Container] [Iteration] [Cycle]
[Approach-Recession]

Lakoff, G. & Johnson, M. (1999) Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought. Basic Books.

Performance Notes for Batroun Concrète (2.1 – 2.9)

Method and Equipment:

1. The piece unfolds by alternating playback of precomposed, fixed duration media recordings (sections 2.1, 2.3, 2.5, 2.7 and 2.9, on computer or CD) with live performed parts (sections 2.2, 2.4, 2.6 and 2.8).
2. The live performances may involve any number of agents and be of any duration.
3. Two high quality loud speakers and a subwoofer are for stereo diffusion, to achieve immersive intensity, with loudness set to room.
4. One high quality stereo microphone (condenser preferred) or two mono microphones (in stereo cross-pair configuration) to amplify objects.
5. Microphone(s) connect to mixer where gain/EQ is adjusted. Mixer amplifies playback of fixed electroacoustic parts.
6. Microphone(s) are to be muted during playback of fixed electroacoustic parts to avoid feedback.

Global Constraints for Live Performances:

Constraint 01: Objects are defined as any materials found in and around the Batroun Project. Only these may be used, in conjunction with the architectural acoustics and recording / amplification equipment.

Constraint 02: In live performance, the agent(s) are free to couple themselves, in any way suitable, with the objects and the acoustical space, forming an assemblage system for generating sound enactively.

Constraint 03: The purpose of the live performance parts is to speculatively explore what that sonic assemblage can do, to find what might be possible.

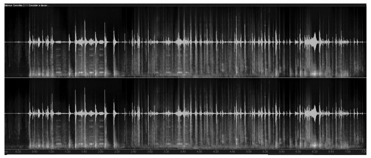
Constraint 04: The intention is to sonically preserve the unfolding enaction between performer body - objects - acoustic- ears. Once the sonic assemblage is sounding, sounds cannot be retrieved, only reconsidered, embellished, or abandoned.

Local Constraints:

- The score on the following pages sets out an overall schematic for the piece, and provides local constraints for each section (2.2, 2.4, 2.6 and 2.8).
- Each page consists of an image, fragments of text and additional notes which are to be freely interpreted while respecting the constraints (global and local).
- The performer-agents have complete latitude in interpreting these components.
- Each of the four live parts is intended to be sonically distinct. They do not imitate the recorded sections, but share the same constraints. They are to be congruent but distinct.
- This score does not specify the sounds themselves, nor their relations in time.
- The score offers a set of considerations to bear in mind, which set the parameters of each speculative performance, emphasising the central idea to be articulated in real-time performance.

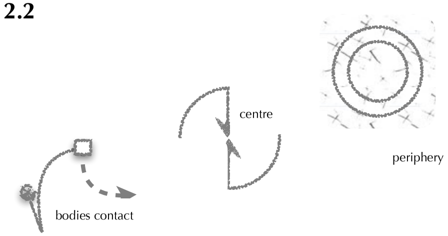
Batroun Concrète 2.1 - 2.9 Schematic

2.1



play stereo file 2.1: duration 7′24″

2.2



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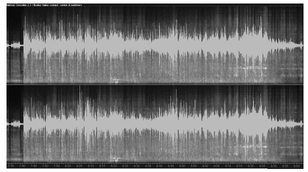
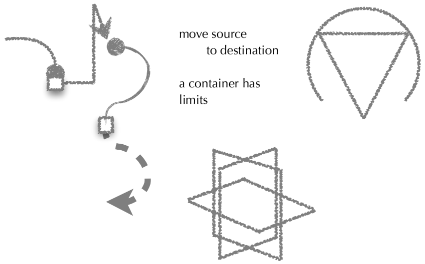


play stereo file 2.3: duration 2′12″

2.4



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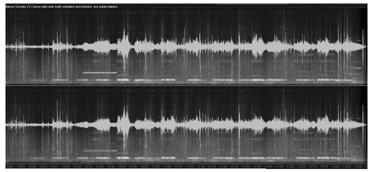
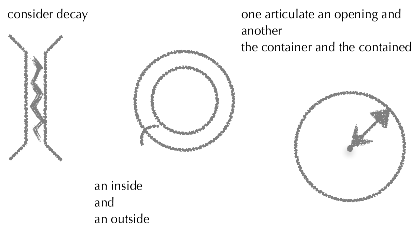
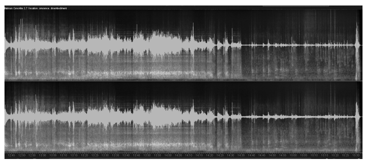


play stereo file 2.5: duration 2′43″

2.6

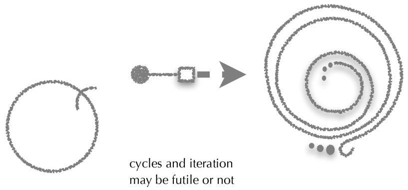


2.7

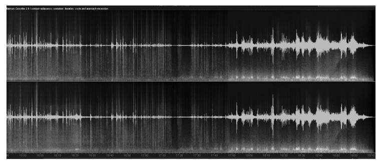


play stereo file 2.7: duration 2′54″

2.8



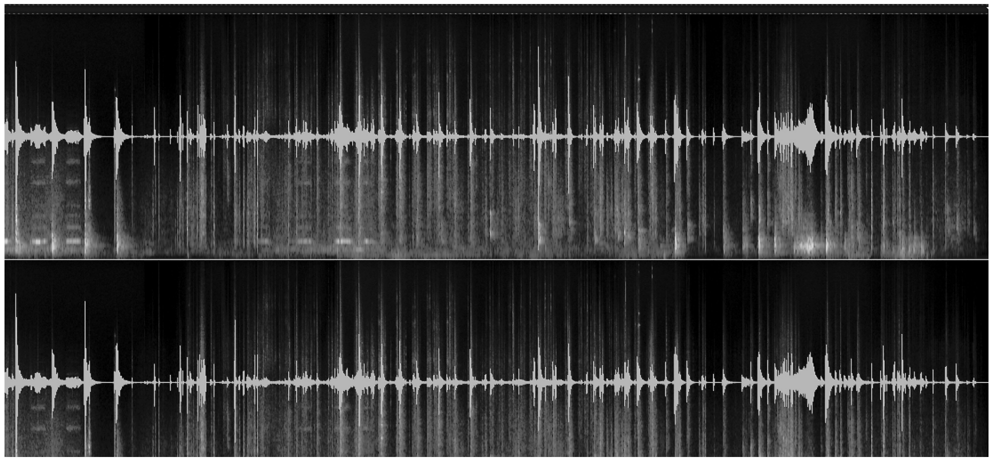
2.9



play stereo file 2.9: duration 3′33″

2.1 Consider decay

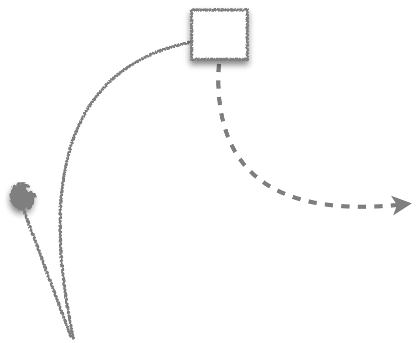
play stereo	section 2.1
duration	7:24



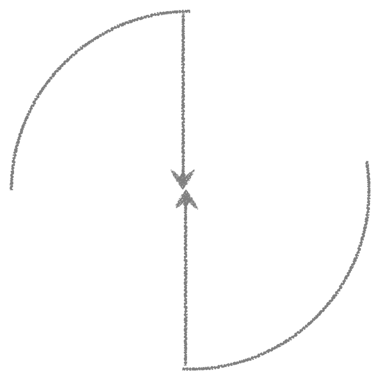
2.2 Live …

Relates to 2.3 and 2.7

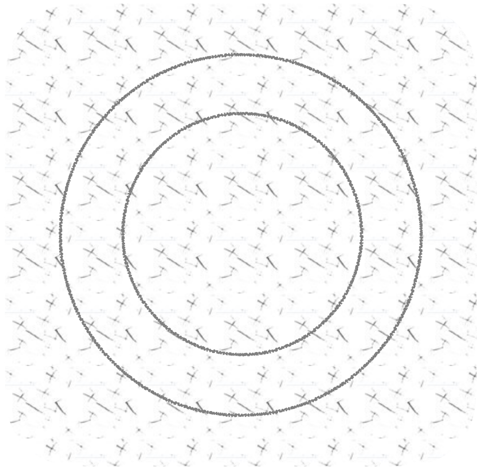
Bodies contact. They have a periphery and a centre



[Movements have trajectory]



[Perimeter -> Centre]

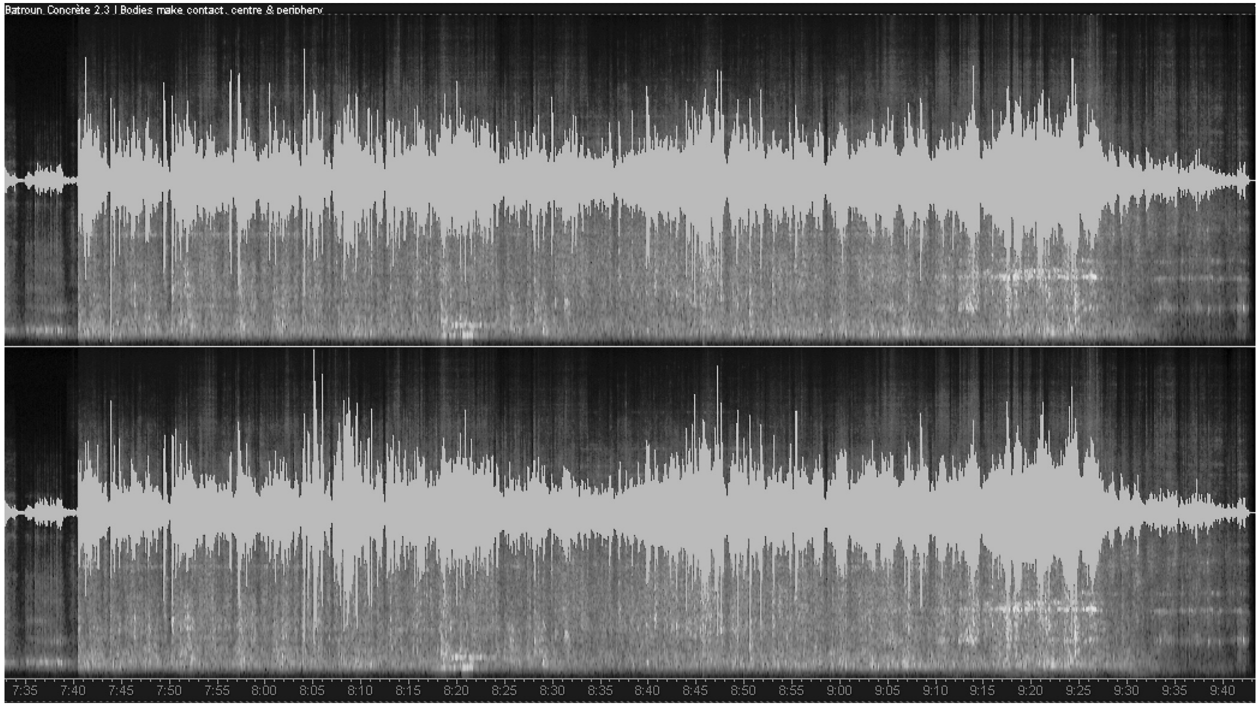


[Container] [Source-Path-Goal]

There is contact between objects and bodies.
Fusion and enfolding into one another.
Figure-ground differentiation becomes indistinct.
Noise = Ganzfeld

2.3 Folding a periphery

play stereo section 2.3
duration: 2:12

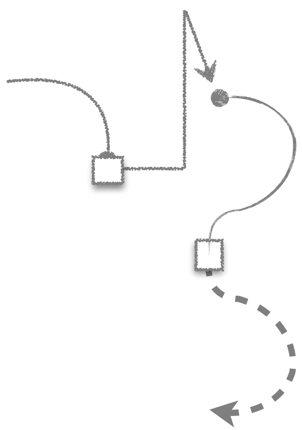


2.4 Live …

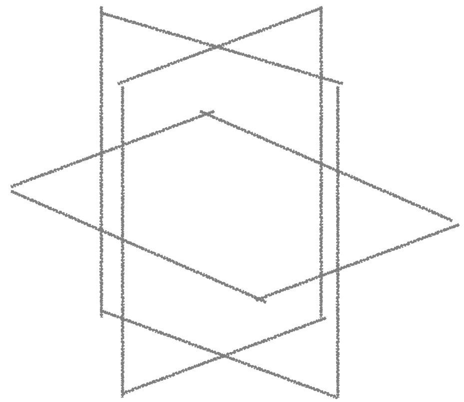
Relates to 2.5

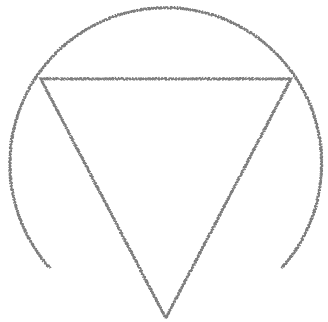
**The source-path-goal constructs a trajectory, a movement from source location to a final destination.
The bodily projection schema deals with orientation and spatial position**

[Basic-Level Cognitive Models]



[Source-Path-Goal]



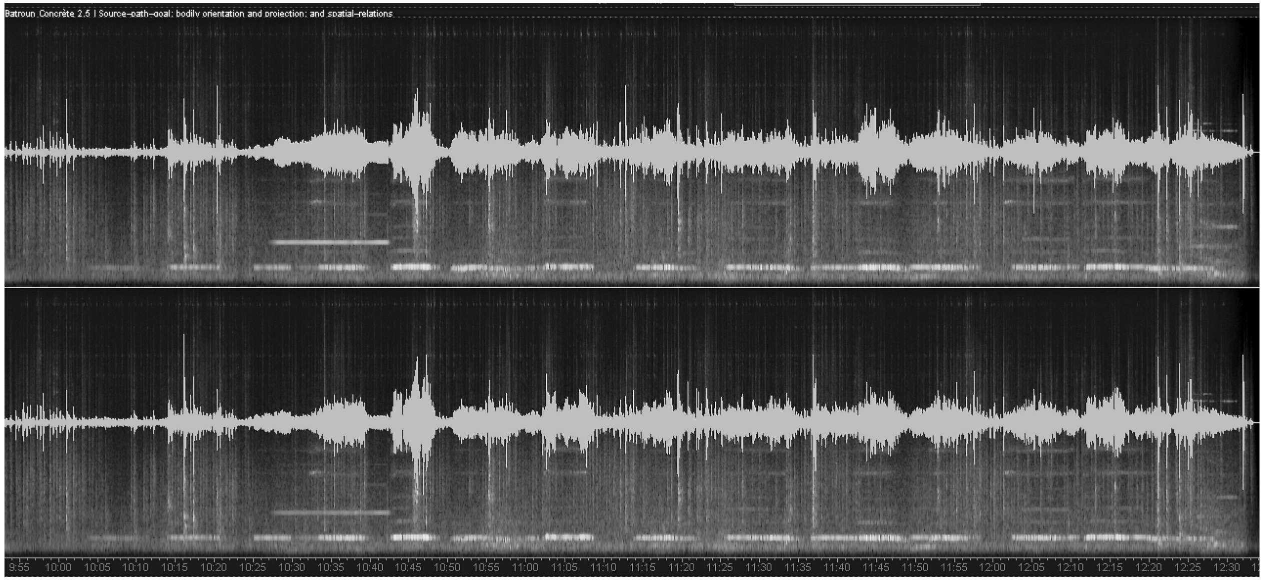


[Orientation and Bodily Projection ————————————————]

Organised pitch and breath
Rhythm
Pace
Ambulatory-ambulant
Oscillations
Gait as frame
The human form as reference

2.5 Contact a centre

play stereo section 2.5
duration: 2:43

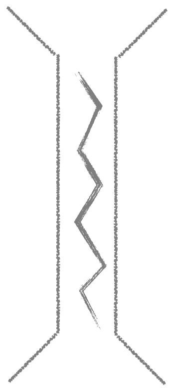


2.6 Live …
Relates to 2.1 and 2.3

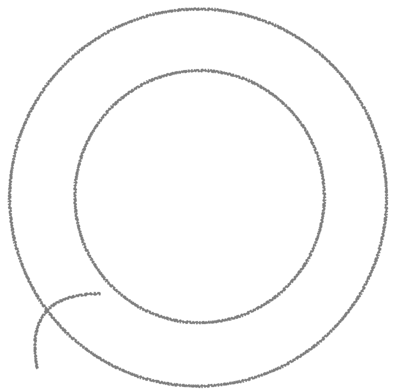
The container is a bounded space in a region. It constructs an interior/exterior. It protects the containers contents, restricts their motion and renders the interior inaccessible to vision.

[Basic-Level Cognitive Models]

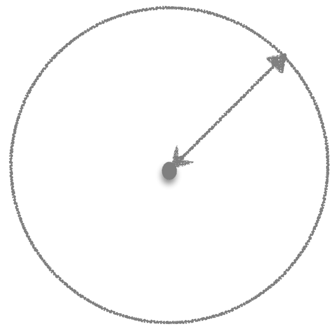
Consider a decay
An inside and outside
One space articulates an opening and another
The container and the contained



[Contact] [Adjacency]



[Centre-Periphery]

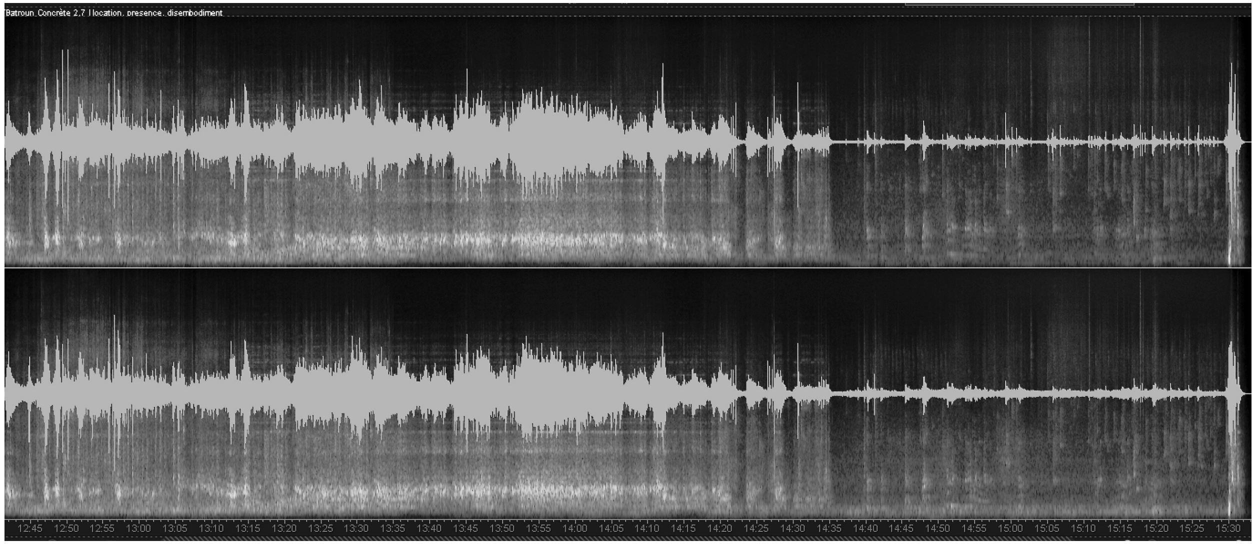


[Bodily Orientation]

Static, rotation of surfaces at a centre (rather than periphery in 2.3)
Contact - surfaces against one another
Emergence of one space, into another, into another
Where are you? (Location, presence, telepresence, identity - one is heard close by, another is absent)

2.7 Are you where?

play stereo section 2.7
duration: 2:54

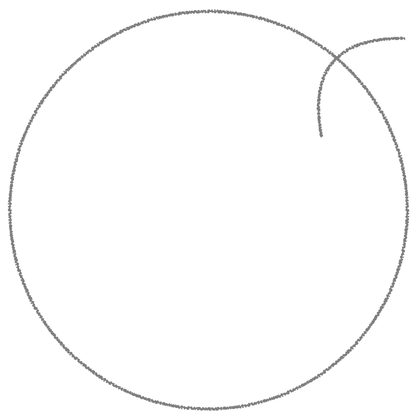


2.8 Live …

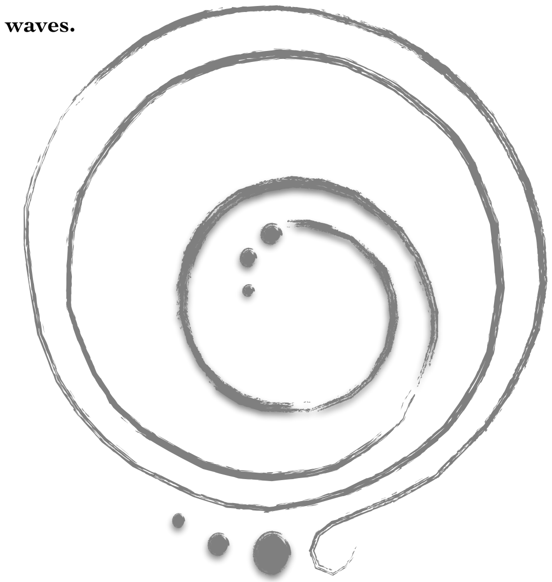
Cycles and iteration.
Repetition may be futile or not.
Elements approach and recede. There may be waves.

[Basic-Level Cognitive Models]

[Contact] [Adjacency]



[Container] [Iteration]

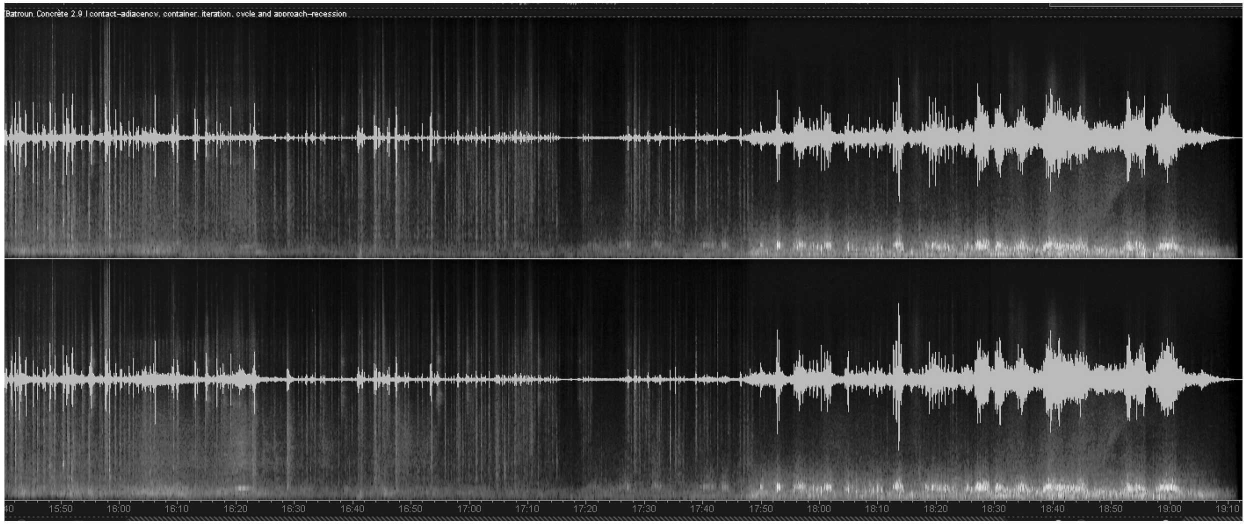


[Cycle] [Approach-Recession]

Earth Air
Aether
Fire Water

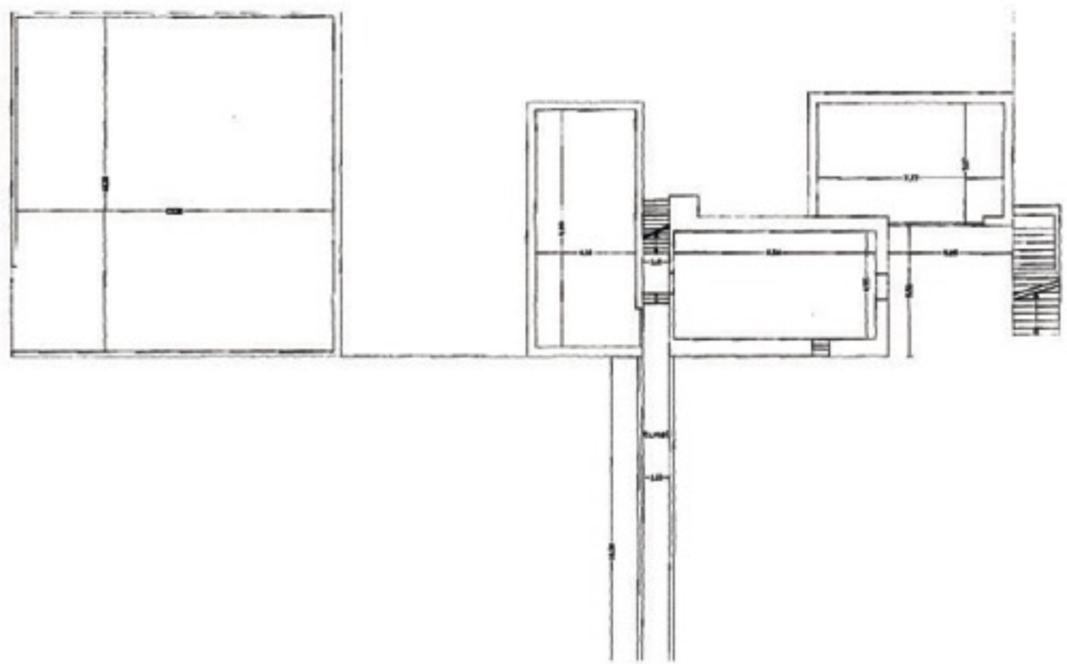
2.9 Elements and aether

play stereo section 2.9
duration: 3:33



Batroun Concrète 2.1 - 2.9

Performance Score for the Batroun Art Space, Batroun, Lebanon



A1.06: Reed | Skin | Elektrik

Project description

The first implementation of the *hQi.live* system was developed for a live performance at Cafe Oto, London, for the MazaJ Festival in London in November 2010. It is a solo work for electronics (built with LiSa and Max/MSP) and nay, Persian daf, bass daf, objects and tuning forks with 4 channel diffusion.

Documentation submitted

Four channel recording of live performance, electro-instrumental (nay, daf, objects, LiSa and Max/MSP) 4 channel.

FORMAT: Two documentations of performance:

1. AUDIO: **live electroinstrumental performance (4 channel; 44.1 KHz audio; duration: 30:32).**
2. VIDEO: **live performance at Cafe Oto, MazaJ Festival, London 2010.**

Diffusion Schematic

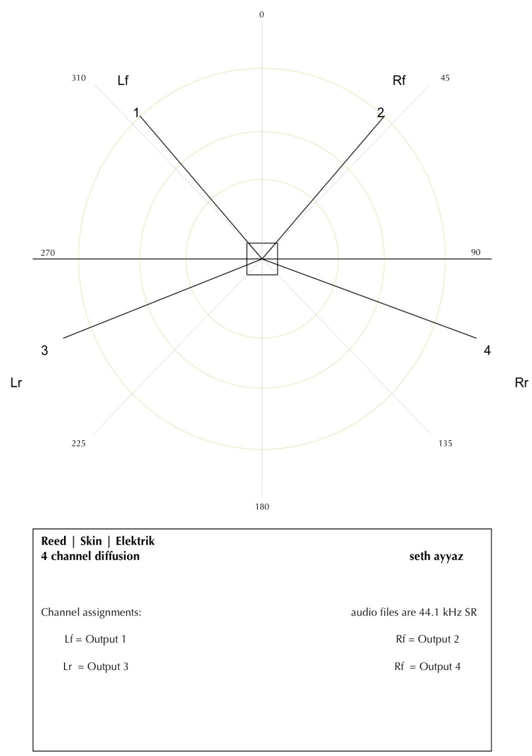


Figure A1.14: Four channel layout for *Reed | Skin | Elektrik*

Selected images

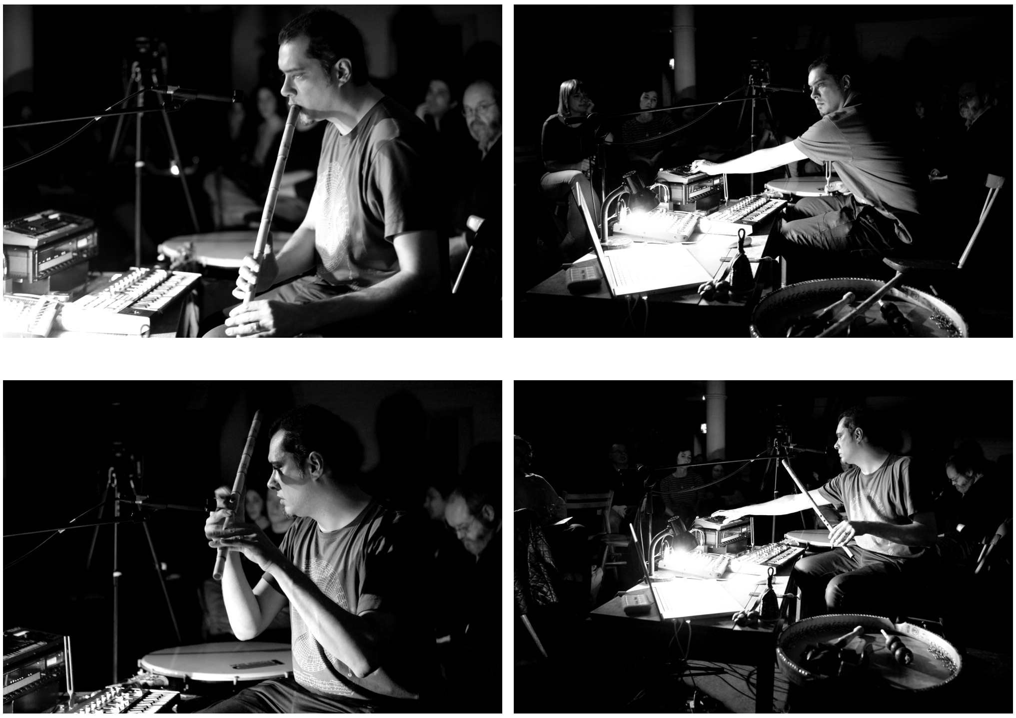


Figure A1.15: *Reed* | *Skin* | *Elektrik* performance, Cafe Oto

A1.07: Dark Geometries

Project description

The most recent iteration of the *hQi.live* system for electro-instrumental performance, using nay, Persian daf, bass daf, turkman drum, metal darbuka, and objects, built-in Supercollider.

Documentation submitted

1. AUDIO: **live electroinstrumental performance (4 channel; 96 KHz audio; duration: 25:34)**.
2. VIDEO: **Blochaus by Gill Ord (no audio, to be played on loop against above duration: 3:55).**

A2: Biopsychosocial materials: Five diagrams of a brain for listening

This appendix presents a set of related schematics that trace the human auditory biosignal and some of its key ramifications. These diagrams provide details about the biological organisation of our brains for music in order to support the arguments made in Chapter 3. The discussion there focuses on the operational significance of these structures rather than the neuroanatomical detail provided here. Additional information is given in the Glossary. Each of the images is accompanied by a description and a brief orienting discussion.

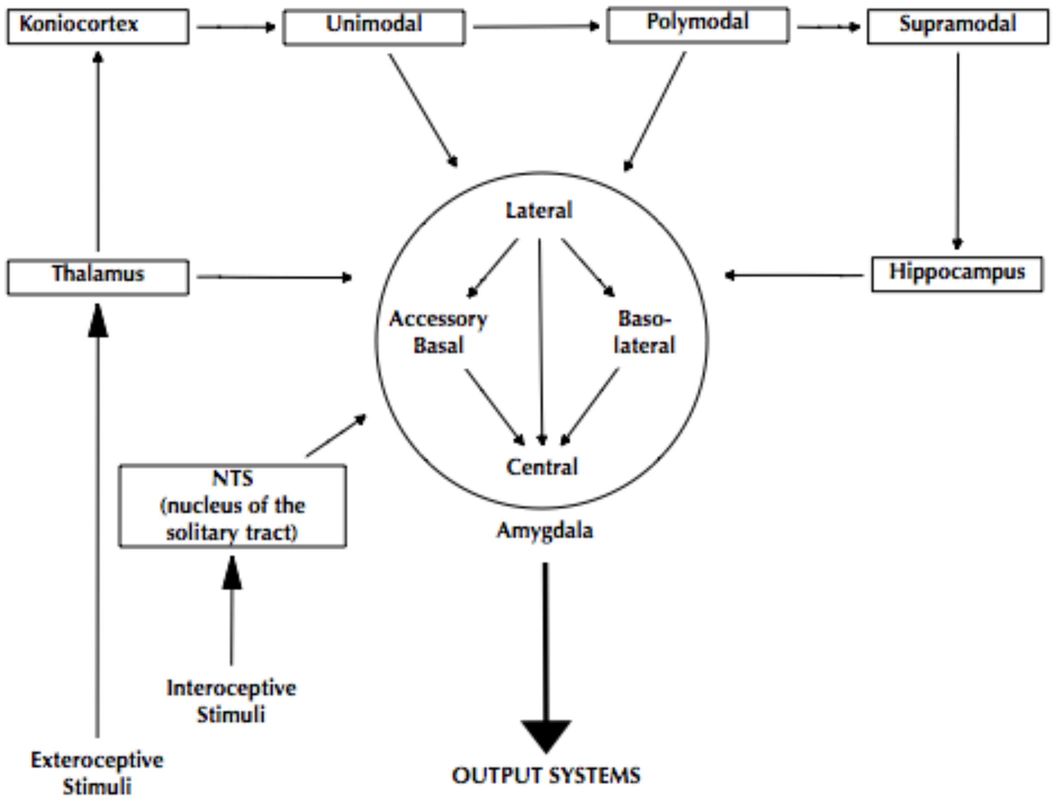
(a) Figure A2:01 is an overview of the thalamocortical emotion 're-entry circuits' that converge and iterate signals from the external world with signals from internal states.

(b) Figure A2:02 replicates Figure 6 and is an overview of the anatomy subserving the visceral reception of sound.

(c) Figure A2:03 replicates Figure 7 and offers a purely neuroanatomical perspective, collating a number of sources into this summary image of the ascending human auditory pathways.

(d) Figure A2:04 replicates Figure 8 and is a schematic including the same features, but offers a more functional account that synthesises classical auditory neuroanatomy with work on the large-scale brain networks which subserve social cognition.

(e) Figure 11 shows three canonical large-scale brain networks (LSBNs) that underpin the 'social brain' and which are critical to high-level cognition.



A2.01: Re-entry circuits

Figure A2.1: LeDoux re-entry emotion circuit (LeDoux, 1996)

The AS (Figure A2:03 and Figure A2:04) and the visceral pathway (Figure A2:02) can be considered as specific examples of a more general emotion 're-entry' circuit (LeDoux, 1996).

In Figure A2:02 we see that the ACs are involved in thalamocortical relay circuits that link cortical functions with the amygdala and hippocampus involved in emotional processing. LeDoux offers a general modal of an emotion or 're-entry' circuit that is shown above. LeDoux sees the thalamus as a centre where non-emotional and emotional information pathways co-exist (LeDoux, 1996). He does not attribute emotional processing power to the thalamus – this is achieved one synapse away by the amygdala through processes of 're-entry'.

Exteroceptive stimuli (from the outside world, such as acoustic signals) pass via the thalamus and onto koniocortex, which is the primary sensory cortex (such as the AC) that projects to modality specific association areas. This unimodal cortex projects into the amygdala and across to polymodal association areas (such as the PT/auditory association area) and onwards to the supramodal or amodal cortex (discussed in Chapter 3, amodal completion in AO formation).

There is a continuous circuit of re-entrant activity going from the subcortical limbic structures, hippocampus (important to memory) and the various cortices that link response with external stimuli and ‘interoceptive’ stimuli. These latter give a continuous feed from the internal body states. The somatic markers continuously bath the brain and are fundamental to music-evoked emotion (Habibi and Damasio, 2014). The NTS (nucleus of the solitary tract) in the medulla is one of the major loci of termination of the vagus nerve, which supplies visceral ‘gut’ afferents. It contains somatic and visceral afferent fibres, as well as general and special visceral efferent fibres. With respect to sound, the net result is that external sound, internal states, emotion, cognition and an array of output responses are in constant circulation.

Re-entry allows temporally tethered, but spatially separated neural networks to fire together synchronously and in parallel. Binding is an important part of re-entry. It facilitates the way neurons, neural networks, and neural maps – both locally and globally – are linked to each other and to perceptual objects. Re-entry makes it possible to speak of a ‘network architecture’ where simple rules allow the brain to combine a great variety of signal processing structures with the capacity to integrate and globalise activities of the brain, both from the top-down and bottom-up (Edelman, 1989; Changeux, 2009).

A2.02: Visceral sound

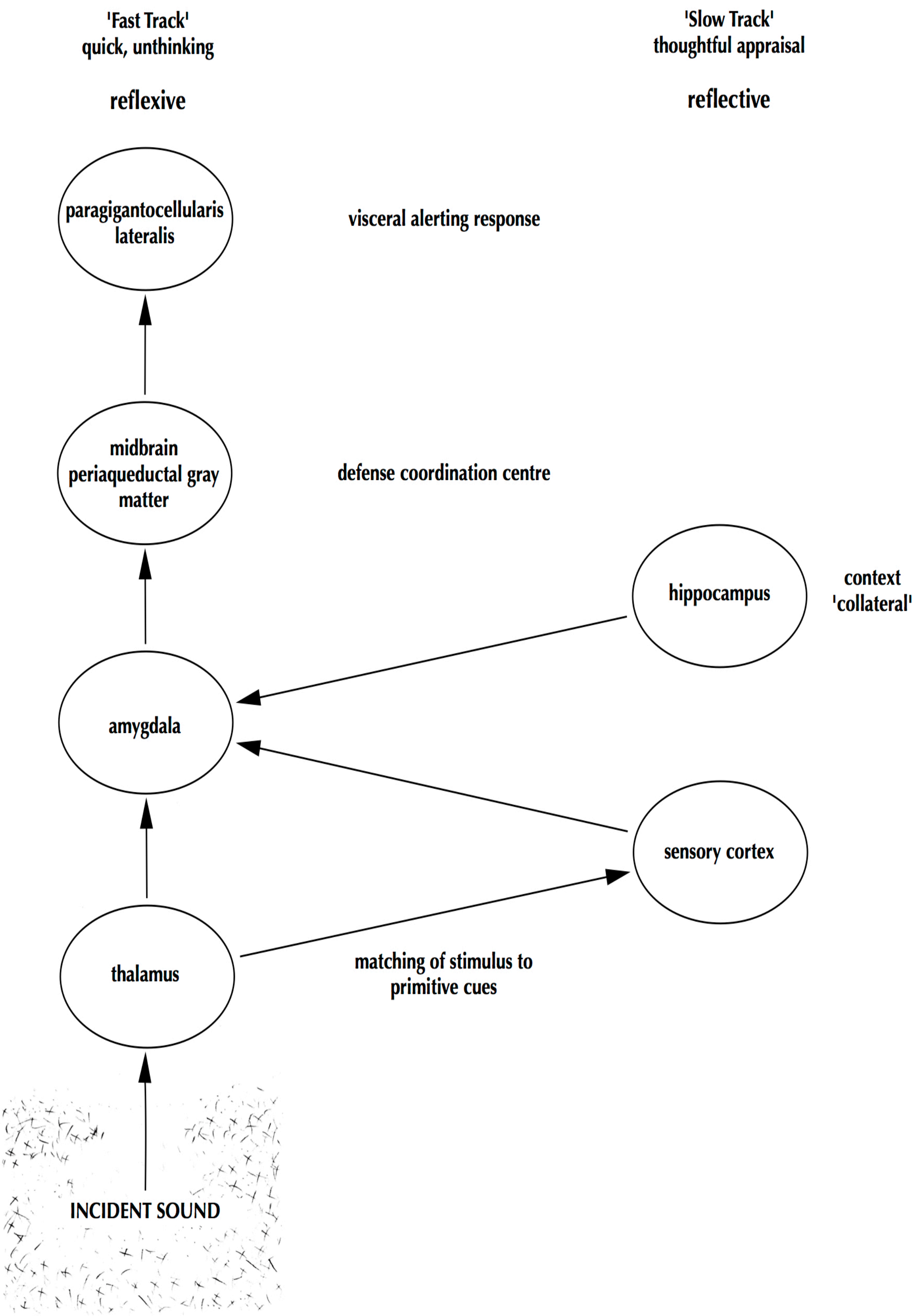


Figure A2.2: Visceral reception of sound. Neural pathways involved in emotional responses to surprise events (adapted from Huron, 2006: 20)

The fast-track limbic pathway (on the left), and the slower cortical pathway (on the right) operate concomitantly and interactively.

Incident sound passes first through the thalamus before reaching the sensory ACs and forming auditory objects that may enter into conscious appraisal. The quick and dirty fight–flight–freeze appraisal of the auditory scene scans for potential danger, and is based upon evolutionarily ancient environmental cues. Incident sound is automatically scanned at the mid-brain level to match primitive cues (such as sudden loud sounds) that indicate potential imminent threat, leading to emotion-driven defence co-ordinated behavioural responses.

The slow-track evaluates the thalamic signal via the ACs that feedback down into the amygdala which is also modulated by memory inputs from the hippocampi that provide contextual and collateral learnt collateral information. This yields a reflective and thought-appraised evaluation of the event stimulus. This is an example of a thalamocortical re-entry circuit (Figure A2.01).

I want to connect Huron's fast and slow track neural pathways, to the 'cochleal listening' and 'visceral reception that I suggested in Chapter 3. There is a difference between my account, and Huron (2006). He assumes the fast-track as arising from sound sensed via the cochlear nerves and does not discuss non-cochlear contributions to the visceral reception of sound. The paragigantocellularis lateralis (PGL) appears to be the main site of convergence of midbrain, visceral and somatic inputs. It not only receives signals relayed from the cochleal routes, but also a wide array of afferent input from the abdominothoracic viscera – what we colloquially call 'gut feeling' (Lovick, 1987; Peng *et al.*, 1998).

This region regulates the same fundamental homeostatic functions that underpin emotion (in general) and music-evoked emotion (Zec and Kinney, 2001; Habibi and Damasio, 2014). My suggestion is that sound sensed via the cochlear route converges with sound sensed via the visceral, non-cochlear routes probably through the PGL to tap fundamentally into our affectively charged apprehension of sound. This visceral-affective aspect of sound – what I am calling visceral reception – is rather marginal in much of the auditory neuroscience literature perhaps suggesting a line of future research.

A2.03: Ascending auditory neuroanatomy

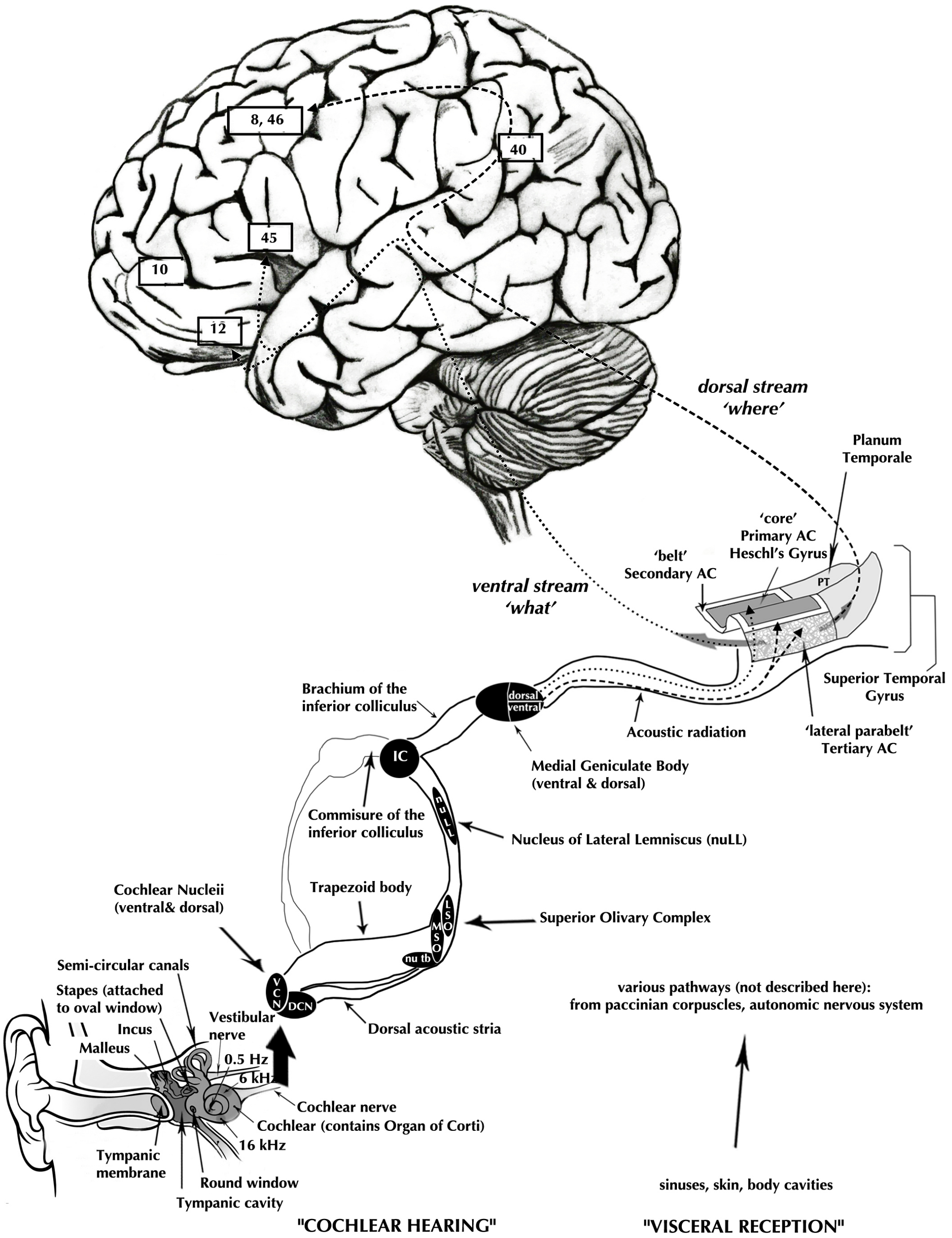


Figure A2.3: The ascending human auditory pathway (adapted from Bear et al., 2006: 364; Nieuwenhuys et al., 2008: 733–50; Malmierca and Hackett, 2010: 26)

Abbreviations: VCN (ventral cochlear nucleus), DCN (dorsal cochlear nucleus), nu tb (nucleus of the trapezoid body), MSO (medial superior olive), LSO (lateral superior olive), nu LL (nucleii of the lateral lemniscus), IC (inferior colliculus), MGB (medial geniculate body) with dorsal and ventral nucleii, STG (superior temporal gyrus), PT (planum temporale) which is associative cortex.

The boxed numbers indicate Brodmann Areas. These refer to classical neuroanatomical maps first described by Brodmann in the early 20th century, who observed that the cerebral cortices had differing cellular architectures (Bernal and Perdomo, 2008).

Bottom right: Visceral reception is shown. Acoustic energy is transduced via a variety of sensory receptors outside of the ear, e.g. paccinian corpuscles in the skin, sensory cells in the skull sinuses, as well as interoceptive sensation in the viscera (abdominothoracic cavities). No detail is shown here, and the relative contribution of different routes to conscious audition is unclear. It is likely to make a significant contribution to sound-evoked affect especially with high intensity and very low frequency sound. See also Figure A2.02 which shows a pathway described by David Huron, 2006.

From bottom left: The outer, middle ear and cochlea are shown. The relative position of frequency coding along the basilar membrane coiled in the cochlea is indicated. The cochlear and semi-circular canals of the vestibular apparatus are closely linked, indicating the proximity of hearing and physical orientation and movement. The pathway continues through the cochlear nerve (Cranial Nerve VIII) to the cochlear nucleii in the brain stem. Primary encoding completes at this stage (see also Figure A2.04). The biosignal projects through the dorsal acoustic stria, superior olivary complexes, nucleus of the lateral lemniscus, inferior colliculus, and medial geniculate body. It undergoes extensive decussations through which the two ears are compared. Secondary complex processing is completed through the mid-brain to the MGB (see also Figure A2.04). The signal projects from dorsal and ventral MGB, through the temporal acoustic radiation to the auditory cortices (AC) on Heschel's gyrus shown in detail on the right: core AC (also known as primary AC), the belt (secondary AC) and lateral parabelt (tertiary AC). Auditory object formation is subserved by processes at the level of the AC, equating to tertiary symbolic or semantic processing (see also Figure A2.04).

Top: The view shows a left lateral view of the human neocortex. At the base can be seen the brainstem, with the cerebellum positioned posteriorly. The extensive auditory connectivity with the cerebellum is not shown.

From the AC, two streams are shown:

The **dorsal 'where' stream** originates in the caudal parabelt and projects posteriorly to BA 40 and onwards to frontal areas BA 8, 12 and 46. It subserves the spatial localisation and trajectory tracking of auditory stimuli (Nieuwenhuys *et al.*, 2008: 743). BA 8 subserves motor imagery and learning, proprioception, auditory imagery, linguistic expression, working memory, episodic memory retrieval, visuomotor and visuospatial attention, executive planning and behavioural inhibition (Bernal and Perdomo 2008). BA 46 subserves language expression, working memory, episodic memory encoding, behavioural inhibition, emotional experiencing and processing, and music enjoyment (Bernal and Perdomo, 2008).

The **ventral 'what' stream** can be seen originating from the anterior belt and parabelt and projecting fronto-temporally to BA 10, 12, 13, and especially 45 (Nieuwenhuys *et al.*, 2008: 743). BA 45 is associated with Broca's area for explicit speech and semantic retrieval or semantic working memory processes and hence (in addition to some language functions) this 'what' stream subserves identification and recognition of auditory stimuli (Gabrieli *et al.*, 1998; Simons and Spiers, 2003; Nieuwenhuys *et al.*, 2008). BA12 is OPFC and associated with learning, reversing associations of visual and other stimuli to primary reinforcers and in controlling and correcting reward-related and punishment-related behaviour, and thus emotion (Rolls, 1999). BA 13 (which cannot be seen on this view) is involved with motor, touch and vibration sensing, linguistic expression, the inhibition of behavioural expression, and fear responses (Bernal and Perdomo, 2008). BA10 subserves auditory imagery, language comprehension and expression, working memory encoding and retrieval, selective attention to sounds, executive planning, behavioural inhibition, emotional processing, and theory of mind (ibid).

The image omits the descending pathways involved with the top-down influence on perception. Similarly, the extensive connections with the cerebellum that govern temporal synchronisation and movement related to rhythm are omitted.

A2.04: Ascending pathway

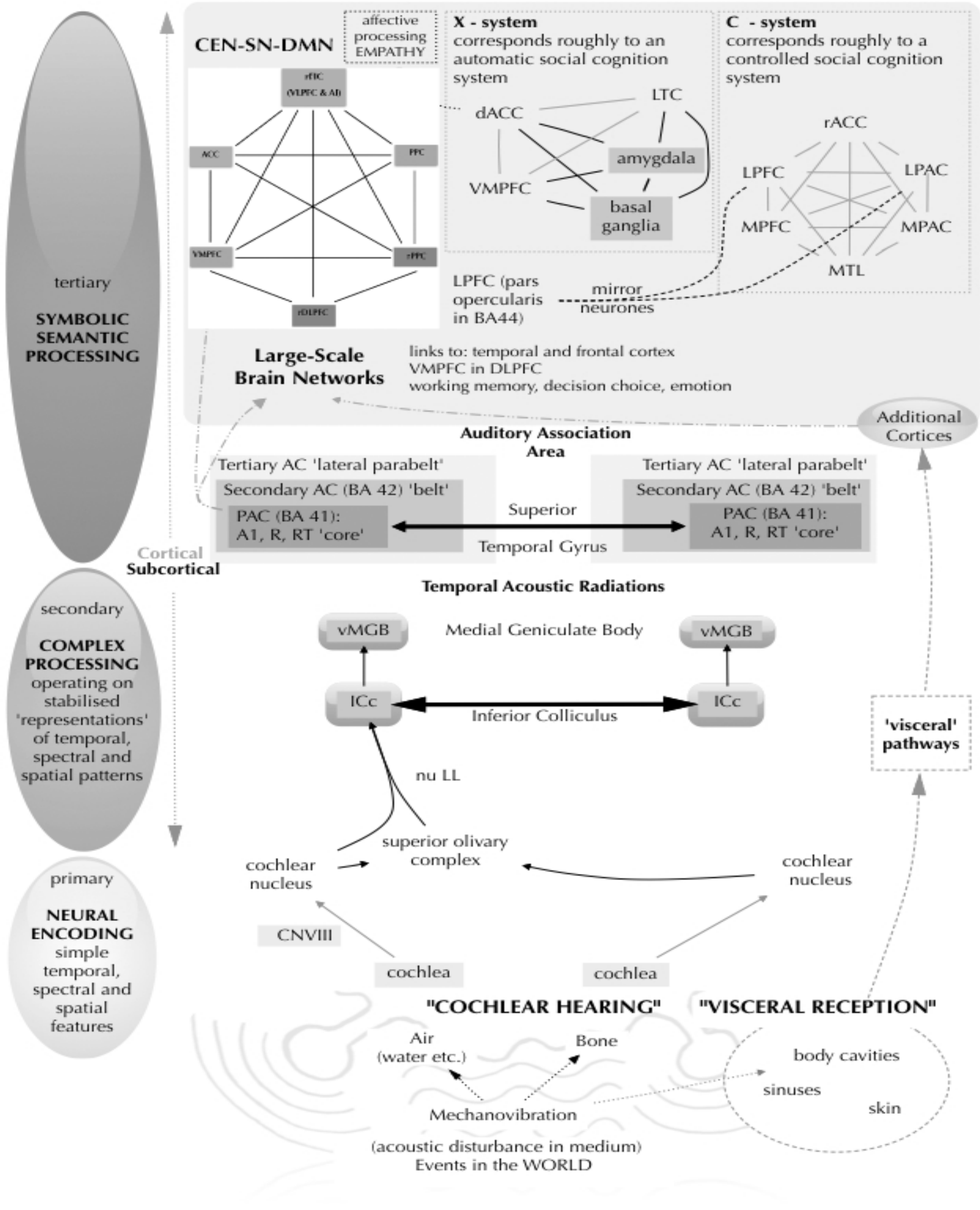


Figure A2.4: Ascending auditory pathway showing three auditory cognitive processing steps (after Griffiths et al., 1999; Griffiths and Warren, 2004; Winkler et al., 2009) and selected large-scale brain networks involved in social cognition (after Satpute and Lieberman, 2006; Lieberman, 2007)

Abbreviations: A1 (primary auditory cortex), AC (auditory cortex), ACC (anterior cingulate cortex), BA (Brodmann Areas, given by number), CH (cochlear nucleus), CNVIII (vestibulocochlear or eighth cranial nerve), dACC (dorsal anterior cingulate cortex), DLPFC (dorsolateral prefrontal cortex), IC (inferior colliculus), ICc (central nucleus of inferior colliculus), LPAC (lateral parietal cortex), LPFC (lateral prefrontal cortex), LTC (lateral temporal cortex), MGN (medial geniculate nucleii), MPAC (medial parietal cortex), MPFC (medial prefrontal cortex), MTL (medial temporal lobe), nu LL (nucleii of the lateral lemniscus), PAC (primary auditory cortex) , PCC (posterior cingulate cortex), R (rostral area of primary auditory cortex), rACC (rostral anterior cingulate cortex), rDLPFC (rostrodorsolateral prefrontal cortex), rFIC (right fronto-insular cortex), rPCC (rostroposterior cingulate cortex), RT (rostrotemporal area of primary auditory cortex), SOC (superior olivary complex), TL (temporal lobe), vMGB (ventral division of the medial geniculate body), VMPFC (ventromedial prefrontal cortex).

Bottom right: Visceral reception is shown again, as a transduction of mechanovibrational energy brought about by acoustic disturbance of a medium. This medium has two senses here. Firstly, at the boundary of air (or water, etc.) with the surface of the body, through for example skin or skull sinuses. Secondly, high intensity sound directly causes mechanovibration of body tissues, especially in the abdominothoracic cavity. These pathways are relatively less well defined and understood and so are schematically referred to as ascending 'visceral' pathways. See also Figure A2.02, which shows a pathway described by David Huron linked to music-evoked emotion (Huron, 2006).

On the left: three ellipses locate major processing steps in relation to anatomical pathways. The terms primary, secondary and tertiary encoding are taken from Griffiths, Rees and Green's (1999) model of complex sound perception and auditory object formation.

From bottom left: The pale grey indicates the peripheral nervous system and early brainstem associated with the **primary encoding** of temporal, spectral and spatial patterns within the acoustic signal. The mid grey indicates **secondary complex processing** that operates on the primary encoding to form stabilised detection of temporal, spectral, and spatial patterns. This is completed through ascending the brainstem through to the nuclei of the lateral lemniscus (nu LL) and the midbrain, which includes the inferior colliculi and medial geniculate nuclei. The neural correlates of the sound stream ramifies through a series of brainstem relays, synapsing widely and decussating between left and right sides, which is critical for signal comparison (interaural time, phase, intensity and spectral differences). This pre-cortical processing critically instantiates the hierarchical grouping and segregation processes of auditory scene analyses described by Albert Bregman and is below the level of conscious meaning or appraisal (Bregman, 1990). The dark grey indicates **tertiary processing** at the cortical level, where auditory 'tokens' exchange symbolic and semantic meaning (Griffiths *et al.*, 1999; Griffiths and Warren, 2004). The pathway projects chiefly through the temporal radiations to the ACs and also directly to the cerebellum (not shown).

The AS is involved with brain regions recruited by movement in the perception of sound, and the ACs link directly to motor regions in both motor cortex and the phylogenetically more ancient cerebellum. The cerebellum is critical to the control of motor functions and subserves the perception of rhythm, time in general and emotion perception (Lane *et al.*, 1997; Zatorre *et al.*, 1999; Parsons, 2001; Pallesen *et al.*, 2005; Skipper *et al.*, 2005; Zatorre, 2007; Thaut *et al.*, 2009; Grahn, 2012; Knolle *et al.*, 2012; Thaut, 2013).

In humans, the major part of the acoustic radiation goes to the primary auditory cortex (PAC) on Heschl's gyrus in the TLs, but a significant proportion radiate to the supplementary audio cortices – the secondary auditory cortex (belt), and tertiary auditory cortex (lateral parabelt) (Malmierca and Hackett, 2010). Figure 8 shows the planum temporale, adjacent to the ACs. This is the auditory association cortex, a 'computational hub' gated to higher-order cortical areas (Griffiths and Warren, 2002).

Top box: Large-scale brain networks are indicated as follows:

Top left: DMN-CEN-SN. Three canonical networks of social cognition – default-mode network, central-executive network, salience network (Satpute and Lieberman, 2006). These are shown in greater detail in Figure 11. They are related to mentalization, our capacity to understand other minds, linking thoughts, feelings and intentions, which is discussed in Chapter 3.

Mentalization networks are not shown in the image, but consist of (Fonagy *et al*., 2002; Vrtička and Vuilleumier, 2012):

- The **social-detection network** is functionally implicated in basic perceptual processing of social stimuli, categorising stimuli as social and deciphering their social purpose. The neural structures include the fusiform face area, superior temporal sulcus, anterior temporal cortex.

- The **emotional-significance network** is functionally implicated in affect, and reward/punishment pathways, giving social stimuli emotional significance, and interacting with interacting with the social-detection subsystem. The generation of affect imbues social stimuli with emotional significance, modulates emotional arousal and has a significant role in mediating attachment experience. The neural structures include the amygdala, hypothalamus, nucleus accumbens, and nucleus of the *stria terminalis*.

- The **cognitive-regulation network** is functionally implicated as having a key role in inhibiting pre-potent responses (effortful control), mediating goal-directed behaviour and mentalizing (in perspective taking and theory of mind tasks). Within this network are several sub-systems that mediate aspects of regulation and control, including integrating emotion with other cognitive processing and making accurate social judgements. The neural structures include the dorsomedial prefrontal cortex, and ventral prefrontal cortex.

Top mid: The neural regions associated with the X-system are the amygdala, basal ganglia, ventromedial prefrontal cortex (VMPFC), lateral temporal cortex (LTC), and dorsal anterior cingulate cortex (dACC) (Lieberman, 2007).

Top right: The neural regions associated with the C-system are lateral pre-frontal cortex (LPFC), medial prefrontal cortex (MPFC), lateral parietal cortex (LPAC), medial parietal cortex (MPAC), medial temporal lobe (MTL) and rostral anterior cingulate cortex (rACC) (ibid).

A2.05: Social brain

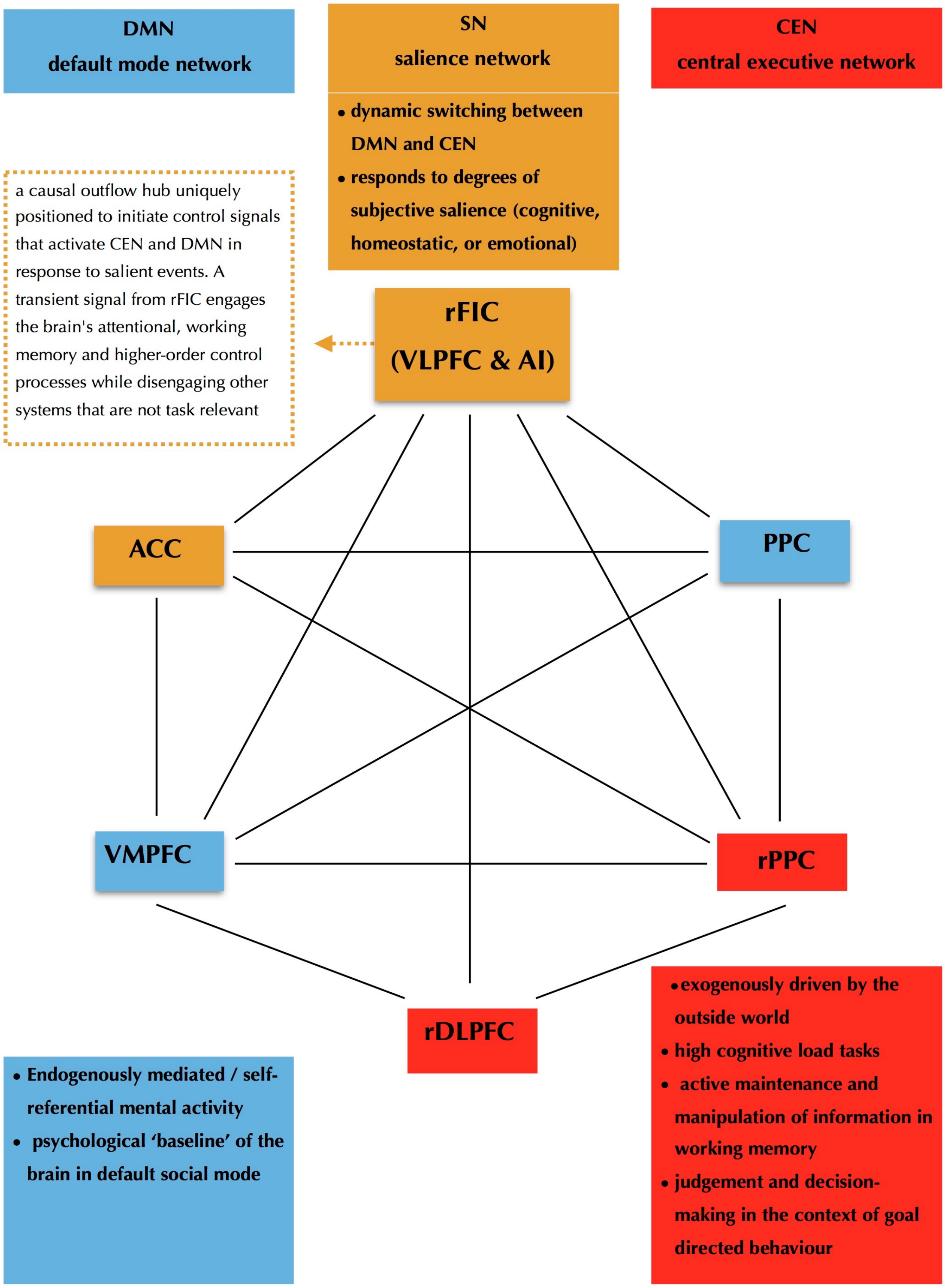


Figure A2.5: DMN, SN, CEN. Three canonical networks of the social brain (developed from Satpute and Lieberman, 2006)

Abbreviations: ventromedial prefrontal cortex (VMPFC), posterior cingulate cortex (PCC), right fronto-insular cortex (rFIC), anterior cingulate cortex (ACC), dorsolateral prefrontal cortex (DLPFC), posterior parietal cortex (PPC).

The activities of three canonical large-scale brain networks (LSBNs) underpin the ‘social brain’ and are critical to high-level cognition (Greicius *et al.*, 2003; Beckmann *et al.*, 2005; Fox *et al.*, 2006; Golland *et al.*, 2007). They have a critical role in music (Sridharan *et al.*, 2008).

Top left (blue): The default mode network (DMN) subserves sociality as the default mode of the human brain. It includes the VMPFC and PCC, associated with internally oriented and social cognition.

Top mid (orange): The salience network (SN) subserves a gating function that directs activity towards significant events in the world via nodes in the right FIC and ACC, involved in attention as well as interoceptive and affective processes.

Top right (red): The central executive network recruits cognitive resources to the task. A frontoparietal network comprising the DLPFC and PPC, related to maintenance and manipulation of information and decision making in the context of goal-directed behaviour.

The CEN is a key process in **working memory** (WM) (Baddeley and Hitch, 1974; Baddeley, 2000; Baddeley, 2003; Snyder, 2009). WM is comprised of several separate memory subsystems. The ‘visual-spatial sketchpad’ (for visualisation, but perhaps for sound we can posit an 'auditory-spatial sketchpad), a ‘phonological loop’ (in speech production) and a ‘central executive’ (executive control of thinking and planning) operate together. They are reciprocally fed from long-term visual (auditory) semantic, episodic and language systems. An ‘episodic buffer’ was added in later versions. In addition, there are other forms of WM such as for motor actions, and non-speech sounds (Jonides and Smith, 1997: 263–5). Various kinds of WM operate across different neural assemblies distributed across the brain. WM is therefore an umbrella concept that describes persistence that occurs on differing temporal scales in different processing systems (Crowder, 1993). It operates as a functional workspace linked to the central executive control of thinking and planning, which is associated with frontal cortical circuits. As an example, with respect to pitch perception, WM recruits and engages interactions between ACs, parietal, premotor cortices and their supplementary areas, cerebellum, as well as dorsolateral and inferior frontal areas, especially under high load conditions (i.e. mentally demanding and effortful scenarios) (Peretz and Zatorre, 2005). WM for musical meaning recruits the middle temporal gyri and left anterior temporal areas (Koelsch and Siebel, 2005). This recruitment of neuronal assemblies across different regions is typical for more general WM, and appears to be the way in which specialised subsystems are brought into coherence in cognitive tasks, including in music perception.

Bottom: The three networks work together, with the SN switching between DMN and CEN. This image is incorporated at the top left of Figure 9.

Such LSBNs subserve our capacities to mentalize (to link a thought with a feeling, and to have an idea of our minds’ ‘aboutness’) and for our mind-brains to synchronise and exchange across shared interpersonal manifolds.

Abbreviations

A1	primary auditory cortex
AC	auditory cortex
ACC	anterior cingulate cortex
ACs	auditory cortices
Ai	audio input stream used in *Makharej* assemblage
AO	auditory object
AOA	auditory object analysis
AOs	auditory objects
AS	auditory system
ASA	auditory scene analysis
BA	Brodmann Areas given by number
BC	*Batroun Concrète* (composition)
BGZ	*The Bird Ghost at The Zaouia* (composition)
BPS	biopsychosocial
BPS_paC	biopsychosocial approach to post-acousmatic composition
C-E	reflective exteriority (see discussion of mentalization and listening stances)
C-I	reflective interiority (see discussion of mentalization and listening stances)
C-system	reflective system (explicit social cognition)
CEN	central- executive network
CN	cochlear nucleus
CNVIII	vestibulocochlear or 8th cranial nerve
CoP.live	version of *hQi.live* used for Conspirators of Pleasure trio UK tour
CPL	composer-performer-listener
dACC	dorsal anterior cingulate cortex
DAW	digital audio work station
DCN	dorsal cochlear nucleus
DG	*Dark Geometries* (composition)
DLPFC	dorsolateral prefrontal cortex
DMN	default-mode network
E-system	system of exteriority, externally-focused social cognition
EAM	electroacoustic music
EEG	electroencephalogram
EPA	ecological psychology approach (connectionism)
ERAN	early right anterior negativity
ERPs	event-related potentials (seen on EEG)

FE	feature extraction
GUI	general user interface
I-system	system of interiority, internally-focused social cognition
IC	intentional correlate
IC	inferior colliculus
ICc	central nucleus of inferior colliculus
IPA	information processing approach (cognitivism)
ITD	interaural time difference
K-matrix	matrix of musical domains and dimensions, named after Stephen Koelsch
LiSa	Live sampling software by STEIM
LPAC	lateral parietal cortex
LPFC	lateral prefrontal cortex
LSBNs	large-scale brain networks
LSO	lateral superior olive
LTaBoID	*Listening Through A Beam of Intense Darkness* (publication and exhibition)
LTC	lateral temporal cortex
MGB	medial geniculate body
MGN	medial geniculate nucleii
MIR	music information retrieval
MMN	mismatch negativity (seen on EEG)
MPAC	medial parietal cortex
MPFC	medial prefrontal cortex
MSO	medial superior olive
MTL	medial temporal lobe
NCC	neural correlate of consciousness
NTS	nucleus of the solitary tract
nu LL	nucleii of the lateral lemniscus
nu tb	nucleus of the trapezoid body
OOP	object-oriented programming
OPFC	orbital prefrontal cortex
PAC	primary auditory cortex or perception-action cycle.
PC	phenomenal correlate
PCC	posterior cingulate cortex
PFC	prefrontal cortex
PGL	paragigantocellularis lateralis
PSM	phenomenal self model
PT	planum temporale
rACC	rostral anterior cingulate cortex

rDLPFC	rostrodorsolateral prefrontal cortex
rFIC	right fronto-insular cortex
R ǀ S ǀ E	*Reed Skin Elektrik* (composition)
RIA-helix	reception-interpretation-action helix (derived from Peircean semiotics)
rPAC	rostral area of primary auditory cortex
rPCC	rostroposterior cingulate cortex
RT	rostrotemporal area of primary auditory cortex
SAC	secondary auditory cortex
[sch]	'schemata' analysis text file used in *Makharej* assemblage
SN	salience network
SOC	superior olivary complex
[Sr]	response synthesiser used in *Makharej* assemblage
ST	spectrotemporal
STG	superior temporal gyrus
TAC	tertiary auditory cortex
TL	temporal lobe
TMN	theory of mind networks
TOM	theory of mind
VCN	ventral cochlear nucleus
vMGB	ventral division of the medial geniculate body
VMPFC	ventromedial prefrontal cortex
WA	Wernicke's Area
WM	working memory
X-E	reflexive exteriority (see discussion of mentalization and listening stances)
X-I	reflexive interiority (see discussion of mentalization and listening stances)
X-system	reflexive system (implicit social cognition)

Glossary

Adhan	(Arabic: مدينة). Ritual call to prayer consisting of three iterations of 'God is the greatest', two repetitions each of 'I witness that there is no god but God,' 'I witness that Muhammad is the messenger of God,' 'Come to prayer,' 'Come to prosperity,' and 'God is the greatest.' At the end, 'There is no god but God' is repeated (Esposito 2004: 7).
Āyah / āyāt	(Arabic: آية; plural: āyāt آيات) means "evidence" or "sign". In the context of the Qur'an, ayah is used to mean "verse", i.e. each statement or paragraph marked by a number.
BPS_paC	Biopsychosocial approach to post-acousmatic composition.
Edge	see 'vertex'.
Hadith	(Arabic: حديث) the words, actions, or habits of the Islamic prophet, Muhammad.The term comes from the Arabic meaning a "report", "account" or "narrative". Hadith are second only to the Quran in developing Islamic jurisprudence, and are regarded as important tools for understanding the Quran and commentaries (tafsir) written on it. Some important elements of traditional Islam, such as the five salat prayers, are mentioned in hadith.
iqa/iqaat	(Arabic: إيقاع īqāʿ; plural: إيقاعات / īqā'āt), in Islamic music, rhythmic modes—i.e., patterns of strong, intermediate, and weak beats, separated by pauses of various lengths. A well-developed system of such modes was described by medieval theorists. Although six or eight basic modes are included in most treatises, many more have actually been used (Encyclopaedia Britannica).
Koniocortex	Primary sensory cortices. Project to modality specific association areas (Mesulam et al 1977).
makhraj/makharej	(Arabic: ض; plural: مخارج makharej). In Arabic language pedagogy, makhraj means the 'place of articulation' or points within the vocal apparatus from where the arabic letters are produced. There are seventeen such points and twenty-nine letters. In the Islamic religious traditions rooted in orality / aurality, exact preservation of the sound of each letter, and the special combinations of letters has special

	emphasis. makharej is also used colloquially to mean a denouement, to make a graceful exit from a difficult situation.
maqam/maqammat	(Arabic: مقام; plural: maqāmāt, maqammat) is the system of melodic modes used in traditional Arabic music. The word maqam in Arabic means place, location or position.
nucleus of the solitary tract	In the medulla, one the major locus of termination of the vagus nerve (visceral afferents). Projects to the amygdala, the bed nucleus of the stria terminalis and some hypothalamic nuclei (Mesulam et al 1977).
Object-relation	An object is something physical that is perceived by an individual and becomes an agent for psychological identification, as in 'the mother is the primary object of the child'. Objects are entities within our mental landscapes that are partially formed from learning, ingested inwards from sensory experience, but equally fused and formed with internal affectively charged processes. Within the British object-relations school, with its roots in the Melanie Klein's development of Freud's insights, an 'internal object' is a mental and emotional image of an external object that has been taken inside the self. The character of these internal objects are coloured by aspects of self that have been projected into it, thus setting up a complex interaction that continues throughout life, between the world of internalised figures and objects, and the external world of real objects (which are also contained in the mind). Object formation is a normal and fundamental part of psychic development and comes about through repeated cycles of projection and introjection. The term 'object' within this tradition is therefore a more complex entity than the object that I have discussed with respect to the neuroscience and perceptual psychology literatures. Internal objects powerfully informs the meanings that we associate with perception, and are related to one another, forming malleable networks of (usually) unconscious meanings and motivations.
Object-relations Theory	Psychoanalytic object relations theories may be defined as those that place the internalisation, structuralisation and clinical reactivation (in the transference and counter-transference) of the earliest dyadic object relations at the centre of their motivational (structural, clinical, and genetic and developmental) formulations. Internalisation of object relations refers to the concept that, in all interactions of the infant and child with the significant parental figures, what the infant

	internalizes is not an image or representation of the other ("the object"), but the relationship between the self and the other, in the form of a self image or self representation interacting with an object image or object representation. This internal structure replicates in the intrapsychic world both real and fantasised relationships with significant others (Kernberg 2005).
Polymodal association cortex	Includes arcuate frontal cortex, banks of superior temporal gyrus. Projects to cingulate gyrus, prorhinal, subrhinal and entorhinal cortices (Mesulam et al 1977).
Sama' polemic	(Arabic: سَمَاع). Sama means 'listening' and is related to the term 'dhikr' (arabic: ذِكْر) which means 'remembrance' (of Allah). The term 'sama' polemic' is developed in Chapter 3 of Kristina Nelson's The art of reciting Qur'an (2001). It can be summarised as the tension arising from negative valuation of music by mainstream orthodox theology and the Sufi justification of music for the enhancement of religious poetry.
Shariah	(Arabic: شريعة) The religious legal system governing members of the Islamic faith. Islamic jurisprudence has a number of different schools and traditions.
Taqsim	Taqsim (Arabic: تَقْسِيم) is a melodic musical improvisation that usually precedes the performance of a traditional Middle Eastern compositions.
Supramodal cortex	Mainly inferior parietal area. Also includes rhinal cortices and cingulate gyrus (Mesulam et al 1977).
Tajwid	(Arabic: تجويد) The ahlam al-tajwid means 'elocution', and is a fixed system of rules which, by convention, govern the recitation of the Qur'an.
Tariqa	(Arabic: طريقة ṭarīqah) is the term for a school or order of Sufism
Tilawa	(Arabic: تلاوة; tilawa or tilawat). Ritual recitation of passages of the Qur'an.
Unimodal association cortex	Locus of projection of koniocortices which project to the amygdala in a modality specific manner and to cingulate gyrus and orbitofrontal cortex (Mesulam et al 1977).

Vertex	The terms 'vertex', 'edge', 'geometry' and 'topos' are conceptually linked. **Psychoanalytic:** The term vertex, in Wilfred R. Bion's terminology, refers to the psychic place from which an emotional experience can be represented with the support of data from a sensory modality, which he called the "mental counterpart" (Bion 1965: 90) of the sense involved. He used the geometric term vertex, "clothing" the abstract concept in imaginary flesh. In so doing, he sought to avoid two pitfalls: that of using a term with strong metaphoric connotations such as point of view, which privileges the sense of sight, and that of reducing the libidinal objects and their processes of intrapsychic transformation to purely formal entities. He nevertheless recognised the primacy of the sense of sight in these processes of transformation, notably, that it leads more readily to verbal description than the other senses. While he emphasised this primacy, he nonetheless showed that a change of vertex, or the mental equivalent of a sensory modality, can be necessary to represent certain psychic experiences. He also described the reversal of a vertex; for example, the reversal of the visual vertex that leads to hallucinations. Bion used the concept of the vertex to describe the relationship between patient and analyst and to propose a theory of interpretation. In the analytic relationship, patient and analyst share the same experience, but each has a different vertex. The patient's vertex is linked to his or her unconscious motivations and their corresponding emotional bonds, the H(hatred) bond or the L (love) bond. The analyst must strive to adopt a vertex that is linked only to the K (knowledge) bond, the emotional bond corresponding to the psychic tension that must be tolerated until meaning emerges. Interpretation for the analyst consists of formulating, when the time comes, his or her experience of the situation based on this vertex. The vertices of the patient and the analyst must be neither too close nor too far apart from one another. This produces a "binocular vision" that enables the patient to take a step back from his or her original vertex, bringing a sort of perspective into the patient's psyche (Houzel 2005: 1833-4).

Vertex (continued)	**Mathemusical:** Although spatial location is a fundamental musical perceptual dimension (see chapter 2: what/where characteristics of the AO), the term 'space' has been productively applied metaphorically and mathematically to convey insights into key musical concepts. Algebraic topology has been a useful approach to spatial representation. > The basic idea is to represent classes of simple musical objects (e.g. pitches, chords or intervals) as elementary spatial domains and to represent the relationships (e.g. their co-occurrence or their succession) as neighbourhood relationships (Giavitto & Spicher 2016: 283). Indeed, the historic link between musical and mathematical theorising has a long lineage which is beyond the scope of the discussion here. Such mathemusical approaches (e.g. Mazzola The Topos of Music (2002), Smith et al., Mathemusical Conversations (2016)), while not the focus of this thesis, are useful to note because they formalise key structural (chiefly syntactical) relations between musical elements. This is consistent with the hierarchy of mental transformations described by Bion, whereby concepts are organised into theory, and theory is organised by 'mathematization'. In considering terms such as vertex, edge, geometry and so forth is a distinction can be made between topological properties and geometrical properties. In topological approaches the connectivity between elements is emphasised, that is the spatial representations which allow the definition of topological notions such as incidence, path, boundary or obstruction (Giavitto & Spicher 2016: 285). Geometrical approaches define spatial relations as properties related to an underlying metric or matrix (as we see with Bion's vertices of projection). Vertex is then (consistent with mathematical convention) an angular point of a polygon, polyhedron, or other figure, a point where two or more straight lines meet in a graph. > Vertex is a synonym for a node of a graph, i.e., one of the points on which the graph is defined and which may be connected by graph edges (Weisstein, 2016: 1). It is therefore related to the term 'edge' which specifies a line, a connection, joining these two nodes. In this writing I shall refer to

	'vertex' as a point within a network of relations between other points. These relations are then 'edges', which is synonymous with 'connection' or 'relation'.Topological relations are those pertaining between vertices i.e. a pattern of connected vertices that then form edges. Geometric relations are those which locate vertices with respect to an underlying matrix (such as grid points located within the K – matrix, or individual vertices within Bion's system of projective relations).
wahdaaniyyah	The indivisible unicity of God. Since there is only one substance, one God, nothing may remain.
zaouia	(Arabic: زاوية; also zawiya, zaouiyah etc) A Maghrebi and West African term for an Islamic religious school or monastery, roughly corresponding to the Eastern term 'madrassa'. It also refers to a Sufi lodge and often contains a pool or a fountain.

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